UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
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Seattle, WA 98115-0070

NMFS Tracking
No. 2003/01293

March 15, 2004

Lieutenant Colonel Edward J. Kertis, Jr.
Department of the Army
Walla Walla District, Corps of Engineers
201 North Third Avenue
Walla Walla, Washington 99362-1876

Re: Endangered Species Act section 7 Formal Consultation and Magnuson-Stevens Act Essential Fish Habitat Consultation for the 2004-2005 Routine Maintenance Dredging in the Lower Snake River Reservoirs. (HUC 17060107, Lower Snake Tucannon).

Dear Lieutentant Colonel Kertis:

In accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended, 16 U.S.C. 1536, and the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996, 16 U.S.C. 1855, the attached document transmits NOAA's National Marine Fisheries Service (NOAA Fisheries) Biological Opinion (Opinion) and MSA consultation on the proposed maintenance dredging in the lower Snake River in Washington and Idaho. The Army Corps of Engineers (COE) determined that the proposed action was likely to adversely affect the ESA listed Evolutionarily Significant Units (ESUs) of threatened Snake River fall chinook (*Oncorhynchus tshawytscha*), threatened Snake River spring/summer run chinook (*O. tshawytscha*), and threatened Snake River Basin steelhead (*O. mykiss*).

This Opinion reflects the results of a formal ESA consultation and contains an analysis of effects covering the ESUs listed above. The Opinion is based on information provided in the Biological Assessment and associated addenda sent to NOAA Fisheries by the COE, and additional information transmitted via telephone conversations, fax, and e-mail. A complete administrative record of this consultation is on file at the Washington State Habitat Branch Office.

NOAA Fisheries concludes that implementation of the proposed project is not likely to jeopardize the continued existence of the previously noted ESUs or result in destruction or adverse modification of designated Critical Habitat. In your review, please note that the incidental take statement, which includes Reasonable and Prudent Measures and Terms and Conditions, were designed to minimize take.

The MSA consultation concluded that the proposed project may adversely impact designated Essential Fish Habitat (EFH) for chinook and coho salmon. The Reasonable and Prudent Measures of the ESA consultation, and Terms and Conditions identified therein, would address the negative effects resulting from the proposed COE actions. Therefore, NOAA Fisheries recommends that they be adopted as EFH conservation measures.

If you have any questions, please contact Mr. Dale Bambrick of the Washington Habitat Branch Ellensburg Field Office at (509) 962-8911 or by email at dale.bambrick@noaa.gov.

Sincerely,

for Michael R Crouse

D. Robert Lohn
Regional Administrator

Enclosure

Endangered Species Act Section 7 Consultation Biological Opinion
and
Magnuson-Stevens Fishery Conservation and Management Act
Essential Fish Habitat Consultation

2004-2005 Routine Maintenance Dredging in the Lower Snake River Reservoirs, Snake River Basin
Asotin, Garfield, Walla Walla, and Whitman Counties, Washington
Nez Perce County, Idaho

Lead Action Agency:	U.S. Army Corps of Engineers
Consultation Conducted By:	National Marine Fisheries Service, Northwest Region
Date Issued:	March 15, 2004
Issued by:	For Michael R Crouse D. Robert Lohn Regional Administrator
NMFS Tracking No.:	2003/01293

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1.0 INTRODUCTION

This document is the product of an Endangered Species Act (ESA) section 7 formal consultation and a Magnuson-Stevens Fishery Conservation and Management Act (MSA) Essential Fish Habitat (EFH) consultation between the NOAA's National Marine Fisheries Service (NOAA Fisheries) and the Army Corps of Engineers (COE). The COE proposes to conduct navigation and maintenance dredging in the lower Snake River and at the mouth of the Clearwater River. The proposed action will occur within the geographic range of four Evolutionarily Significant Units (ESU[1]): endangered Snake River (SR) sockeye salmon (*Oncorhynchus nerka*) threatened Snake River fall (SRF) chinook salmon (*O. tshawytscha*), threatened Snake River spring/summer run (SRSS) chinook salmon (*O. tshawytscha*), and threatened Snake River Basin (SR) steelhead (*O. mykiss*). In addition, the action area is designated as EFH for chinook (*O tshawytscha*) and coho (*O. kisutch*) salmon.

The purpose of the dredging is to maintain a slack water navigation system extending from the Pacific Ocean inland to the cities Lewiston, Idaho, and Clarkston, Washington; restore a portion of diminished flow conveyance capacity (flood control) in the Lewiston-Clarkston area; and maintain access to public areas. The COE proposes the action according to its authority under the River and Harbor Act of 1945 (Public Law 79-14).

This document analyzes whether the anticipated biological effects of dredging and disposal of dredged materials at selected locations in the lower Snake River are likely to jeopardize the continued existence of SRF chinook, SRSS chinook, or SR steelhead, or result in the destruction or adverse modification of their designated critical habitat. Furthermore, this document analyzes whether the proposed action will adversely affect designated EFH for coho and chinook salmon. These ESA and EFH determinations will be reached by analyzing the biological effects of dredging and disposal, relating those effects to the biological and ecological needs of listed species, and then adding these effects to the environmental baseline of the action area.

1.1 Background and Consultation History

NOAA Fisheries received a biological assessment (BA) from the COE on July 28, 2003, and initiated formal consultation at that time. On December 5, 2003, the COE notified NOAA Fisheries by letter that they intended to delay dredging operations until the winter of 2004 - 2005 and that they would not require receipt of this Opinion until mid-January, 2004. The COE determined that the proposed action was "likely to adversely affect" SRF chinook, SRSS chinook, and SR steelhead because individuals of these species would likely be present during dredging and disposal operations or they rely on habitats that would be affected by the proposed action. The COE also determined that the proposed action "may affect" but is "not likely to

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[1] "ESU" means a population or group of populations that is considered distinct (and hence a "species") for purposes of conservation under the ESA. To qualify as an ESU, a population must (1) be reproductively isolated from other conspecific populations, and (2) represent an important component in the evolutionary legacy of the biological species (Waples 1991).

adversely affect" SR sockeye.

The present proposal is a continuation of the COE's efforts to manage accumulated sediments in the lower Snake River reservoirs. On September 26, 2000, the COE requested informal consultation with NOAA Fisheries on a larger, 20-year Dredged Material Management Plan (DMMP). NOAA Fisheries disagreed with the COE's determination that the proposed DMMP was "*not likely to adversely affect*" the Snake River ESUs. The COE subsequently requested formal consultation on June 27, 2001; consultation was initiated on September 27, 2001, reinitiated on May 30, 2002, and concluded with the issuance of NOAA Fisheries' Biological Opinion (Opinion) on July 30, 2002.

In November 2002, the National Wildlife Federation *et al.*[2] sought a preliminary injunction against the COE's implementing the DMMP on the basis that the COE's 2002 DMMP Environmental Impact Statement (EIS) and Record of Decision and NOAA Fisheries' Opinion were inadequate. On December 12, 2002, the U.S. District Court, Western District of Washington, granted plaintiff's motion for preliminary injunction. On April 17, 2003, the parties asked the Court to the stay the case in a joint status report. The COE and NOAA Fisheries subsequently withdrew the Record of Decision and the Opinion, respectively.

The proposed action is presented as a stand alone project to maintain, in the near term, the navigation, public access, and flood control benefits of the lower Snake River dams. The proposed action is also intended to further test the viability of disposing dredged material inwater as a means of providing suitable rearing and foraging habitat for SRF chinook and other ESA listed species. The COE proposes to conduct dredging and disposal operations from December 15, 2004, through March 1, 2005. If the action is delayed beyond the 2004-2005 dredging season it would still be implemented in a single dredging season only between December 15 and March 1. The COE has not determined how to proceed with longer term sediment management needs.

The formal consultation process involved reviewing information contained in the BA, the *Supplemental Environmental Analysis for Purposes of 2003-2004 Dredging* (SEA) (COE and Environmental Protection Agency (EPA) 2003), correspondence and communication between NOAA Fisheries and the COE (numerous phone calls, meetings, and emails), and review of reports and other materials furnished by the COE. This consultation is also informed by the on-going consultation between NOAA Fisheries' Idaho State office and the Environmental Protection Agency regarding the proposed issuance of a National Pollution Discharge Elimination System permit for the Potlatch Pulp and Paper Mill in Lewiston, Idaho. The complete administrative record is available at the NOAA Fisheries Washington State Habitat Branch Office in Lacey, Washington.

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[2] Washington Wildlife Federation, Idaho Wildlife Federation, Idaho Rivers United, Pacific Coast Federation of Fishermen's Associations, and Institute for Fisheries Resources.

1.2 Proposed Action

Proposed actions are defined in theUnited States Fish and Wildlife Service and NOAA Fisheries (Services') consultation regulations (50 CFR 402.02) as "all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas." In addition, the MSA (16 U.S.C. 1855(b)(2)) further defines a Federal action as "any action authorized, funded, or undertaken or proposed to be authorized, funded, or undertaken by a Federal agency." Because the COE proposes to implement dredging and dredged material disposal operations that may affect listed resources, it must consult under ESA section 7(a)(2) and MSA section 305(b)(2).

Complete descriptions of the proposed action are included in the BA and SEA. The following paragraphs describe the primary project elements relevant to ESA listed species and EFH for chinook and coho salmon.

1.2.1 Navigation and Maintenance Dredging

The COE proposes to dredge approximately 275,000 cubic yards of accumulated sediments from portions of the lower Snake River navigation system (the navigation channel, port facilities, and the navigation lock approaches) in order to maintain a minimum depth of 14 feet within the channel when reservoirs are at minimum operating pool. The channel would be dredged to a maximum depth of 16 feet to account for imprecision in the dredging process and to ensure that a depth of 14 feet is maintained for a reasonable period of time. In addition, the COE would dredge approximately 40,000 cubic yards of accumulated sediment to maintain access to recreational and commercial facilities. Dredging at the port sites would provide a maximum depth of 15 feet, and dredging at the recreational facilities would provide maximum depths of four to eight feet. A summary of locations and quantities of materials proposed for dredging is listed in Table 1.

Dredging would be accomplished mechanically; either by clamshell, dragline, backhoe, or shovel/scoop. The COE anticipates that most of the material would be removed with a clamshell dredge. Dredging would commence not earlier than December 15, and would conclude not later than March 1. Dredging would last for 10 - 24 hours per day, six to seven days per week. The COE anticipates that dredging would progress at a rate of 375-625 cubic yards per hour. Dredged material would be placed on a waiting barge for later transport to a disposal site. While the barge is being filled, excess water may be overspilled back into the river.

The BA delineates templates within which dredging may occur at each proposed dredging location. However, as the extent of the actual dredging footprint depends on the bottom elevation within the dredging template, the entire template area will not likely be dredged at any location. For example, at Lower Granite Dam, the navigation lock approach dredging template encompasses 28% of the Lower Granite Dam tailrace area, but the portion scheduled for dredging encompasses 1.2% of the tailrace area. Similarly, at Lower Monumental Dam, the template encompasses 26% of the tailrace area, and the dredging footprint would be limited to

3.4%. At the confluence of the Snake and Clearwater Rivers, the COE proposes to dredge approximately 63.2 acres, or roughly 12.5% of the 500-acre bank-to-bank confluence area. At the Greenbelt Boat Basin site, the COE proposes to dredge approximately one acre within the 33.3 acre dredging template.

Table 1: Sites proposed for dredging during 2003-2004, or 2004-2005 and the estimated quanties of material at each location.

Dredge Site	Quantity (cubic yards)	Total Area (Acres)	Predominant Substrate
Federal Navigation Channel at Confluence of Snake and Clearwater	250,500	63.2	Sand (85-90%)
Port of Clarkston	9,600	0.9	Silt (90%)
Port of Lewiston	5,100	1.8	Silt (90%)
Greenbelt Boat Basin	2,800	1.0	Sand (45%) and Silt (35%)
Swallows Swim Beach	16,000	2.2	Sand (56-67%) and Silt (21-27%)
Lower Granite Dam Lock Approach	4,000	1.5	Cobble/Rock (100%)
Lower Monumental Dam Lock Approach	20,000	6.06	Rock/Cobble (100%)
Illia Boat Launch	1,400	1.0	Silt (86-95%)
Willow Landing Boat Launch	6,200	1.4	Sand (56-67%) and Silt (21-27%)
Total	**315,600**	**79.06**	

1.2.2 Dredged Material Disposal

The COE proposes to beneficially use all material suitable for inwater disposal by shaping spoil deposits to form shallow water rearing and foraging habitats for juvenile salmonids, and woody riparian areas to benefit salmon and terrestrial species. It is anticipated that 85% of the material would be sands, gravels, and cobbles. The remaining 15% is expected to be silts and finer grained material. Dredged material disposal would not commence before December 15 and would conclude not later than March 1.

The COE will not specify the disposal method to the contractor, but will require the contractor to meet performance standards. These include: adhering to water quality standards and achieving satisfactory depth, shape, and composition of the shallow water habitat feature. Regardless of the placement method selected, the disposal process would include initially dumping material in large mounds. During this phase, silts that are deemed suitable for inwater disposal may be dumped, provided they are later buried beneath enough sand to ensure the thickness of the sand mantle is at least 10 feet. Finally, the deposits would be shaped to create a smooth-surfaced bench as described below. It might also be necessary to support the spoil mound by placing an array of cobbles around its base.

For the subject dredging action, the COE proposes to dispose of material near Knoxway Canyon, at river mile 116. This 44-acre mid-depth site was selected because it is reasonably close to where most of the dredging will occur and because previous investigations suggest that very few salmonids rear or loiter in the area. Disposal here would create a sandy bench with a one foot vertical to 10 foot horizontal slope, providing a range of mid (10-20 feet) and shallow depth (zero-ten feet) rearing and foraging habitat across the expected range of operating elevations in Lower Granite Reservoir. The COE would also create a woody riparian habitat feature here which would be essentially an upland extension of the shallow water habitat feature. Again, the COE would not prescribe the disposal methods, but the contractor would be required to meet performance standards.

Previous testing suggests that some sediments within the action area are contaminated with a wide array of pollutants. To minimize risks to listed species and the aquatic environment, the COE would place upland any material that contains contaminant concentrations greater than those identified in the *Lower Columbia River Dredged Material Evaluation Framework* (COE, *et al.* 1998). Silt deposits generally contain greater concentrations of contaminants than do deposits of larger grained materials. The COE proposes to further limit the risk of contaminant exposure by either burying those silts deemed safe for inwater disposal beneath a 10-foot thick mantle of sand in the shallow water habitat bench, or disposing of them upland as capping material for the woody riparian bench. Material not suitable for inwater disposal will be disposed of at an appropriate upland site.

1.2.3 Monitoring

To minimize negative effects associated with the proposed dredging operations, the COE would implement a number of monitoring programs to which dredging operations would be responsive. Monitoring programs would include water quality, sediment contamination, and SRF chinook redd distributions. The data collected from monitoring activities may also be used to guide future dredging operations, to the extent that further operations are implemented, minimizing their impact on listed species.

1.2.3.1 Water Quality Monitoring

Turbidity, ammonia, temperature and pH levels would be monitored during dredging and disposal operations.

Monitoring at dredging sites. The COE would require the dredging contractor to take water samples and measure turbidity using a nephalometer twice per day during active dredging. The contractor would take samples one hour after dredging began and one hour before dredging ended each day. Samples would be taken approximately 300 feet upstream from the dredging operation and roughly 300 feet directly downstream from the point of dredging. The contractor would take two measurements at each location - at roughly three feet below the water surface and roughly three feet above the river bottom. The contractor would be required to notify the COE within eight hours in the event that the turbidity levels of the dredging operation exceeded allowable levels. These levels are defined as five nephalometric turbidity units (NTUs) over background when the background is 50 NTUs or less, or not more than a 10% increase in turbidity when the background is more than 50 NTUs. Background levels would be measured 300 feet upstream of the dredging operation. Immediately upon detecting non-compliance with this NTU limit, the contractor would alter the dredging operation in an attempt to decrease turbidity levels. Monitoring would continue at the downstream location to determine if the NTU levels either returned to an acceptable level or remained high. If the levels remained high the contractor would stop dredging and wait for the NTU levels to return to compliance levels before resuming dredging. If the contractor is unable to meet turbidity requirements, the COE would be contacted for additional instructions.

Ammonia levels would be monitored using techniques similar to those for turbidity monitoring. However, ammonia monitoring would vary in intensity depending on substrate composition. In areas that are expected to be predominately sand, gravel, or cobble (greater than 75% by weight), water quality monitors outfitted with ammonia probes and turbidity monitors (as well as other water quality measuring probes) would be positioned about 300 feet upstream and downstream of the dredging operations. In addition, an array of buoys, fitted with monitors would be deployed roughly 650 feet, and possibly 1,600 feet downstream. The dredging and disposal activity would be monitored to determine if ammonia levels were exceeded, similar to the turbidity monitoring. If the concentrations of ammonia were found to be high, modification of the dredging operations would occur in a manner similar to those outlined for turbidity. More monitors may be needed downstream, however, to determine the persistence of ammonia in the water column and mixing zones. If altering of the dredging or disposal activity were determined to have no effect on lowering the concentration of ammonia, the contractor would cease operations and consult with the COE regarding how to proceed.

In areas with high concentrations of silt, including backwater areas and boat basins, ammonia monitoring would be more intense. Ammonia has a higher potential to bind with silts than with larger substrate particles. Accordingly, operations that mobilize silts pose a greater risk of ammonia exposure to fish than those involving larger particles. For this reason, the COE is proposing an adaptive management approach to monitoring ammonia levels at dredging sites in silty areas, and at inwater dredge material disposal areas.

Ammonia monitoring at boat basins would minimally include sampling in four key zones of each individual site. Depending on the site size, one or more monitors would be strategically positioned inside the area to be dredged. The second zone would contain at least one monitor in the opening of the backwater area to determine if ammonia were entering the main river. The third zone would be in the main river downstream of the backwater entrance to determine potential concentrations and dispersal as mixing of water from the mainstem and backwater occurs. The fourth zone would be upstream from the boat basin, and used as a control. If concentrations of ammonia are found to be high, dredging operations would be modified. Such modifications may include slowing dredging operations to reduce total turbidity and ammonia suspension. If modifications are ineffective, it would be necessary to isolate the dredging within a physical barrier.

Monitoring at disposal sites. Ammonia monitoring would occur in at least three zones at the disposal site in a manner similar to the turbidity monitoring. The first would be approximately 300 feet upstream from where the material would be deposited at the Knoxway Canyon site, and the second and third would be within the expected turbidity plume to measure the ammonia concentrations at distances of roughly 300 and 1,000 feet from the release site. If the concentrations of ammonia exceed allowable limits, the contractor would be required to modify the disposal activity. If altering the dredging or disposal activity were determined to be ineffective, the contractor would cease operations and consult with the COE regarding how to proceed.

1.2.3.2 Sediment Contaminant Monitoring

The COE has sampled all of the proposed dredge sites for sediment type and contaminant level. Chemical sampling was conducted on sediments for polynuclear aromatic hydrocarbons (PAHs), organophosphates, chlorinated herbicides, oil, grease, glyphosate, amino methyl phosphonic acid (AMPA), dioxin, and heavy metals. None of the contaminants were found in concentrations high enough to require their handling as hazardous waste (COE and EPA 2001, 2003).

In addition to the chemicals described above, the COE would also monitor ammonia levels in sediments targeted for dredging. Ammonia is a contaminant of concern because of its toxicity to fish and because it occurs in relatively high concentrations in riverbed silts in the lower Snake River. Sediments that are mobilized during dredging may contain ammonia concentrations that are high enough to negatively affect freshwater fishes (COE and EPA 2001). Specifically, the COE evaluated elutriation data, average concentrations of sediment ammonia, and pH within each of the lower Snake River reservoirs and then performed a risk analysis using these data and the chronic and acute ammonia criterion for fish from the National Criterion for Ammonia in Fresh Water (EPA 1999). The COE determined that potential effects varied for each reservoir. In the Lower Granite Reservoir, the potential risk from ammonia exposure was judged to be extremely high because the elutriate ammonia average (3.6 mg/L at 8.5 pH) could exceed the early life stage criterion three-fold and could exceed both acute criterions (2.14 mg/L with salmon present, and 3.20 mg/L with salmon absent). Potential effects from ammonia in the Little Goose, Lower Monumental, and Ice Harbor reservoirs were judged to be moderate because the elutriate ammonia average could exceed the chronic early life stage criterion.

1.2.3.3 Redd Distribution Monitoring

Dredging in the lock approaches of Lower Granite and Lower Monumental Dams has a small potential to disturb SRF chinook redds. Accordingly, the COE will survey these areas prior to dredging, using the protocol established by Dauble *et al.* (1995). If a redd is located within the footprint of proposed dredging activities, the COE will notify NOAA Fisheries and the two agencies will jointly determine whether it is better to modify the dredging footprint to avoid the redd or postpone dredging to a later date (*i.e.*, after emergence of incubating embryos). Redds are not expected to be present in the lock approaches because they have not been observed there previously. The lock approaches contain some areas of suitable water depth and substrate size, but water velocities are apparently too low to encourage SRF chinook spawning. The redd surveys would provide definitive presence/absence data useful for ensuring that SRF chinook redds would not be adversely affected by dredging.

1.3 Description of the Action Area

An action area is defined by the Services' regulations (50 CFR Part 402) as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The action area directly affected by the proposed action begins at the Swallows Park Boat Basin on the Snake River at approximately river mile 142 and extends downstream to the Lower Monumental Dam Navigation Lock approach at approximately river mile 41. The action area also extends upstream from the confluence of the Clearwater and Snake Rivers to approximately river mile 1.2 on the Clearwater River. Both adult and juvenile life stages of each of the aforementioned ESUs use the action area as a migration corridor. The action area also provides spawning and rearing habitat for SRF chinook, although very little SRF chinook spawning occurs here. Some adult SR steelhead and juvenile SRSS chinook also overwinter here. The action area includes areas indirectly affected by the proposed action, and extends upstream from proposed dredging sites into all anadromous fish bearing portions of the Snake River Basin, as the maintenance of the lower Snake River navigation system enables a multitude of habitat-affecting activities. These places serve as spawning, rearing, and migration habitat for all of the aforementioned ESUs. The entire action area is designated EFH for chinook salmon, and portions are designated EFH for coho salmon.

2.0 ENDANGERED SPECIES ACT - BIOLOGICAL OPINION

The objective of this Opinion is to determine whether the effects of the proposed 2004-2005 dredging, together with the effects of the baseline and cumulative effects, are likely to jeopardize the continued existence of the SRF chinook, SRSS chinook, or SR steelhead, or destroy or adversely modify their designated critical habitat.

2.1 Evaluating the Effects of the Proposed Action

The standards for determining jeopardy and destruction or adverse modification of critical habitat are set forth in section 7(a)(2) of the ESA. In conducting analyses of habitat-altering actions under section 7 of the ESA, NOAA Fisheries uses the following steps of the consultation regulations and when appropriate combines them with The Habitat Approach (NMFS 1999a): (1) Consider the biological requirements and status of the listed species; (2) evaluate the relevance of the environmental baseline in the action area to the species' status; (3) determine the effects of the proposed or continuing action on the species, and whether the action is consistent with any available recovery strategy; and (4) determine whether the species can be expected to survive with an adequate potential for recovery under the effects of the proposed or continuing action, the effects of the environmental baseline, and any cumulative effects, and considering measures for survival and recovery. In completing this step of the analysis, NOAA Fisheries determines whether the action under consultation, together with all cumulative effects when added to the environmental baseline, is likely to jeopardize the ESA-listed species or result in the destruction or adverse modification of critical habitat. If jeopardy or adverse modification are found, NOAA Fisheries may identify reasonable and prudent alternatives for the action that avoid jeopardy and/or destruction or adverse modification of critical habitat.

The fourth step above (jeopardy/adverse modification analysis) requires a two-part analysis. The first part focuses on the action area and defines the proposed action's effects in terms of the species' biological requirements in that area (i.e., effects on essential features). The second part focuses on the species itself. It describes the action's effects on individual fish, populations, or both, and places that impact in the context of the ESU as a whole. Ultimately, the analysis seeks to determine whether the proposed action is likely to jeopardize a listed species' continued existence or destroy or adversely modify its designated critical habitat.

2.1.1 Biological Requirements

The first step NOAA Fisheries uses when applying ESA section 7(a)(2) to the listed ESUs considered in this Opinion includes defining the species' biological requirements within the action area. Biological requirements are population characteristics necessary for the listed ESUs to survive and recover to naturally reproducing population sizes at which time protection under the ESA would become unnecessary. The listed species' biological requirements may be described as characteristics of the habitat, population or both (McElhany *et al.* 2000). NOAA Fisheries has identified interim abundance and productivity targets for each of the Snake River ESUs (Lohn 2002). While there are slight differences in the productivity targets between ESUs, NOAA Fisheries' general objective is to ensure each expresses a recruit-to-spawner ratio of greater than one-to-one. The interim abundance goals are 53,700 SR steelhead, 41,900 SRSS chinook, and 2,500 SRF chinook.

For actions that affect freshwater habitat, NOAA Fisheries may describe the habitat portion of a species' biological requirements in terms of a concept called properly functioning condition

(PFC). The PFC is defined as the sustained presence of natural[3] habitat-forming processes in a watershed that are necessary for the long-term survival of the species through the full range of environmental variation (NMFS 1999a). The PFC, then, constitutes the habitat component of a species' biological requirements. Although NOAA Fisheries is not required to use a particular procedure to describe biological requirements, it typically considers the status of habitat variables in a matrix of pathways and indicators (MPI) (NMFS [1996] Table 1) that were developed to describe PFC in forested montane watersheds. In the PFC framework, baseline environmental conditions are described as "properly functioning," "at risk," or "not properly functioning."

For this consultation, the biological requirements that would be affected by the proposed action are adult and juvenile migration, adult holding, spawning, incubation, rearing, and growth and development to adulthood include substrate, water quality, food, space, and safe passage conditions.

<u>2.1.2 Status and Generalized Life History of Listed Species</u>

In this step, NOAA Fisheries also considers the current status of the listed species within the action area, taking into account population size, trends, distribution, and genetic diversity. To assess the current status of the listed species, NOAA Fisheries starts with the determinations made in its decision to list the species and also considers any new data that are relevant to the species' status.

The COE has determined that the proposed dredging action is likely to adversely affect the SRF chinook, SRSS chinook, and SR steelhead ESUs and designated critical habitat identified in Table 2. Because of the life histories of these ESUs, it is likely that SRF chinook, SRSS chinook, and SR steelhead juveniles, and SR steelhead adults would be adversely affected by the proposed action.

The proposed dredging would occur within designated critical habitat for SRF chinook and SRSS chinook salmon ESU(s). Freshwater critical habitat can include all waterways, substrates, and adjacent riparian areas[4] below longstanding, natural impassable barriers (i.e., natural waterfalls in existence for at least several hundred years) and dams that block access to former habitat (see citations in Table 2). Essential features of critical habitat for the listed species are: (1) adequate substrate, (2) good water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food (juvenile only), (8) riparian vegetation, (9) space, and (10) safe passage conditions.

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[3]The word "natural" in this definition is not intended to imply "pristine," nor does the best available science lead us to believe that only pristine wilderness will support salmon.

[4]Riparian areas adjacent to a stream provide the following functions: shade, sediment delivery/filtering, nutrient or chemical regulation, streambank stability, and input of large woody debris and fine organic matter.

Table 2. References for additional background on listing status, critical habitat designation, protective regulations, and life history for the ESA-listed species considered in this consultation.

Species ESU	Listing Status	Critical Habitat Designation	Protective Regulations	Life History
Chinook salmon (*O. Tshawytscha*				
Snake River fall	Threatened; April 22, 1992; 57 FR 14653[5]	December 28, 1993, 58 FR 68543	July 10, 2000; 65 FR 42422	Waples *et al.* 1991; Healey 1991
Snake River spring/summer	Threatened; April 22, 1992; 57 FR 14653[6]	October 25, 1999, 64 FR 57399[6]	July 10, 2000; 65 FR 42422	Matthews and Waples 1991; Healey 1991
Steelhead (*O. mykiss*)				
Snake River Basin	Threatened Species, August 18, 1997 62 FR. 43937	No Designated Critical Habitat	July 10, 2000; 65 FR 42422	Busby *et al.*, 1996

Snake River Fall Chinook

The Snake River Fall (SRF) chinook salmon ESU, listed as threatened on April 22, 1992 (57 Fed. Reg. 14653), includes all natural-origin populations of fall chinook in the mainstem Snake River and several tributaries including the Tucannon, Grande Ronde, Salmon, and Clearwater rivers. Fall chinook from the Lyons Ferry Hatchery are included in the ESU but are not listed. Critical habitat was designated for SR fall chinook salmon on December 28, 1993 (58 FR 68543).

This ESU includes the mainstem river and all tributaries, from their confluence with the Columbia River to the Hells Canyon Dam. Because genetic analyses indicate that fall-run chinook salmon in the Snake River are distinct from the spring/summer-run in the Snake basin (Waples *et al.* 1991), SRF chinook salmon are considered separately from the other two forms. They are also considered separately from the UCR summer- and fall-run ESU because of considerable differences in habitat characteristics and adult ocean distribution and less definitive, but still significant, genetic differences.

While most SRF chinook spawn above the area targeted for dredging, some have been documented spawning within it, particularly in the tailraces of the dams. The SRF fall chinook

[5] Also see, June 3, 1992, 57 FR 23458, correcting the original listing decision by refining ESU ranges.

[6] This Federal Register Notice corrects the original designation of December 28, 1993, 58 FR 68543 by excluding areas above Napias Creek Falls, a naturally impassable barrier.

are heavily reliant on the action area for rearing and pass through it on their way to the ocean. Some SRF chinook appear to exhibit a stream type life history (Bennett *et al.* 1999) and are likely to be in the action area during dredging operations.

Life History. Fall chinook salmon in this ESU are ocean-type. Adults return to the Snake River at ages 2 through 5, with age 4 most common at spawning (Chapman *et al.* 1991). Spawning, which takes place in late fall, occurs in the mainstem and in the lower parts of major tributaries (NWPPC 1989; Bugert *et al.* 1990). Juvenile fall chinook salmon move seaward slowly as subyearlings, typically within several weeks of emergence (Chapman *et al.* 1991). Based on modeling by the Chinook Technical Committee, the Pacific Salmon Commission estimates that a significant proportion of the SRF chinook (about 36%) are taken in Alaska and Canada, indicating a far ranging ocean distribution. In recent years, only 19% were caught off Washington, Oregon, and California, with the balance (45%) taken in the Columbia River (Simmons 2000).

Some SRF chinook historically migrated over 1,500 km from the ocean. Although the Snake River population is now restricted to habitat in the lower river, genes associated with the lengthier migration may still reside in the population. Because longer freshwater migrations in chinook salmon tend to be associated with more-extensive oceanic migrations (Healey 1983), maintaining populations occupying habitat that is well inland may be important in continuing diversity in the marine ecosystem as well.

Habitat and Hydrology. With hydrosystem development, the most productive areas of the Snake River basin are now inaccessible or inundated. The upper reaches of the mainstem Snake River were the primary areas used by fall chinook salmon, with only limited spawning activity reported downstream from river mile (RM) 272. The construction of Brownlee Dam (1958; RM 285), Oxbow Dam (1961; RM 272), and Hells Canyon Dam (1967; RM 246) eliminated the primary production areas of SRF chinook. There are now 12 dams on the mainstem Snake River, and they have substantially reduced the distribution and abundance of fall chinook salmon (Irving and Bjornn 1981).

Hatchery Influence. Hatchery-reared fall chinook salmon have been released into the Snake River Basin since 1981 (Busack 1991). The hatchery contribution to Snake River escapement has been estimated at greater than 47% (Meyers *et al.* 1998). Artificial propagation is recent, so cumulative genetic changes associated with it may be limited. Wild fish are incorporated into the brood stock each year, which should reduce divergence from the wild population. Release of subyearling fish may also help minimize the differences in mortality patterns between hatchery and wild populations that can lead to genetic change (Waples 1999). (See NMFS [1999b] for further discussion of the SR fall chinook salmon supplementation program.)

Population Trends and Risks. For the SRF chinook salmon ESU as a whole, NOAA Fisheries estimates that the median population growth rate (lambda) over the base period ranges from 0.95 to 0.88, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (McClure *et al.* 2003). NOAA Fisheries has also estimated the risk of absolute extinction for the aggregate SRF chinook salmon population, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness equals zero), the risk of absolute extinction within 100 years is 0.40 (McClure *et al.* 2000). At the high end, assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness equals 100%), the risk of absolute extinction within 100 years is 1.00 (McClure *et al.* 2000).

Snake River Spring/Summer Chinook

The Snake River spring/summer (SRSS) chinook salmon ESU, listed as threatened on April 22, 1992 (57 FR 14653), includes all natural-origin populations in the Tucannon, Grande Ronde, Imnaha, and Salmon rivers. Some or all of the fish returning to several of the hatchery programs are also listed including those returning to the Tucannon River, Imnaha, and Grande Ronde hatcheries, and to the Sawtooth, Pahsimeroi, and McCall hatcheries on the Salmon River. Critical habitat was designated for SRSS chinook salmon on December 28, 1993 (58 FR 68543), and was revised on October 25, 1999 (64 FR 57399).

Most SRSS chinook rear upstream of the impounded portions of the Snake River, however some juveniles are likely to be present in the action area during dredging operations (Bennett *et al.* 1999). All members of the ESU pass through the action area on their adult and smolt migrations.

Life History. In the Snake River, spring and summer chinook share key life history traits. Both are stream type fish, with juveniles that migrate swiftly to sea as yearling smolts. Depending primarily on location within the basin (and not on run type), adults tend to return after either two or three years in the ocean. Both spawn and rear in small, high-elevation streams (Chapman *et al.* 1991), although where the two forms coexist, spring-run chinook spawn earlier and at higher elevations than summer-run chinook.

Habitat and Hydrology. Even before mainstem dams were built, habitat was lost or severely damaged in small tributaries by construction and operation of irrigation dams and diversions, inundation of spawning areas by impoundments, and siltation and pollution from sewage, farming, logging, and mining (Fulton 1968). Recently, the construction of hydroelectric and water storage dams without adequate provision for adult and juvenile passage in the upper Snake River has kept fish from all spawning areas upstream of Hells Canyon Dam.

Hatchery Influence. There is a long history of human efforts to enhance production of chinook salmon in the Snake River basin through supplementation and stock transfers. The evidence is mixed as to whether these efforts have altered the genetic makeup of indigenous populations. Straying rates appear to be very low.

Population Trends and Risks. For the SRSS chinook salmon ESU as a whole, NOAA Fisheries estimates that the median population growth rate (lambda) over the base period ranges from 0.97 to 0.93, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to the effectiveness of fish of wild origin (McClure *et al.* 2003). NOAA Fisheries has also estimated median population growth rates and the risk of absolute extinction for the seven spring/summer chinook salmon index stocks, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness equals zero), the risk of absolute extinction within 100 years for the wild component ranges from zero for Johnson Creek to 0.78 for the Imnaha River (McClure *et al.* 2000). At the high end, assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness equals 100%), the risk of absolute extinction within 100 years ranges from zero for Johnson Creek to 1.00 for the wild component in the Imnaha River (McClure *et al.* 2000).

Snake River Basin Steelhead

The Snake River Basin (SR) steelhead ESU, listed as threatened on August 18, 1997 (62 FR 43937), includes all natural-origin populations of steelhead in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho. None of the hatchery stocks in the Snake River Basin is listed, but several are included in the ESU. Critical habitat is not presently designated for SR steelhead.

Steelhead spawning habitat in the Snake River is distinctive in having large areas of open, low-relief streams at high elevations. In many Snake River tributaries, spawning occurs at a higher elevation (up to 6,000 feet) than for steelhead in any other geographic region. The SR steelhead also migrate farther from the ocean (up to 930 miles) than most.

The SR steelhead are not known to spawn in the impounded reaches of the Snake River, but it is possible that some juveniles overwinter or rear for short periods there. Adult SR steelhead hold in the mainstem Snake and Columbia Rivers for extended periods (months) prior to spawning, and are likely to be in the action area during the proposed work window (Bjornn, *et al*, 2003).

Life History. Fish in this ESU are summer steelhead. They enter freshwater from June to October and spawn during the following March to May. Two groups are identified, based on migration timing, ocean-age, and adult size. A-run steelhead, thought to be predominately age-1-ocean, enter freshwater during June through August. B-run steelhead, thought to be age-2-ocean, enter freshwater during August through October. B-run steelhead typically are 3 to 4 inches longer than A-run steelhead of the same age. Both groups usually smolt as 2- or 3-year-olds. All steelhead are iteroparous, capable of spawning more than once before death.

Habitat and Hydrology. Hydrosystem projects create substantial habitat blockages in this ESU; the major ones are the Hells Canyon Dam (mainstem Snake River) and Dworshak Dam (North Fork Clearwater River). Minor blockages are common throughout the region. Steelhead spawning areas have been degraded by overgrazing, as well as by historical gold dredging, and sedimentation due to poor land management. The watersheds in the Snake basin are warmer and drier and often more eroded than elsewhere in the Columbia River basin or in coastal areas.

Hatchery Influence. Hatchery fish are widespread and stray to spawn naturally throughout the region. In the 1990s, an average of 86% of adult steelhead passing Lower Granite Dam were of hatchery origin. Hatchery contribution to naturally spawning populations varies, however, across the region. Hatchery fish dominate some stocks, but do not contribute to others.

Population Trends and Risks. For the SR steelhead ESU as a whole, NOAA Fisheries estimates that the median population growth rate (lambda) over the base period ranges from 1.02 to 0.96, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (McClure *et al.* 2003). NOAA Fisheries has also estimated the risk of absolute extinction for the A- and B-runs, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness equals zero), the risk of absolute extinction within 100 years is 0.01 for A-run steelhead and 0.93 for B-run fish (McClure *et al.* 2000). At the high end, assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness equals 100%), the risk of absolute extinction within 100 years is 1.00 for both runs (McClure *et al.* 2000).

2.1.3 Environmental Baseline in the Action Area

The environmental baseline is defined as: "the past and present impacts of all Federal, state, or private actions and other human activities in the action area, including the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation and the impacts of state and private actions that are contemporaneous with the consultation in progress" (50 CFR 402.02). NOAA Fisheries evaluates the relevance of the environmental baseline in the action area to the species' current status. In describing the environmental baseline, NOAA Fisheries evaluates essential features of designated critical habitat and the listed Pacific salmon ESUs affected by the proposed action.

In general, the environment for listed species in the Columbia River Basin (CRB), including those that migrate past or spawn upstream from the action area, has been dramatically affected by the development and operation of the Federal Columbia River Power System (FCRPS). Storage dams have eliminated mainstem spawning and rearing habitat, and have altered the natural flow regime of the Snake and Columbia Rivers, decreasing spring and summer flows, increasing fall and winter flow, and altering natural thermal patterns. Power operations cause fluctuating flow levels and river elevations, affecting fish movement through reservoirs, disturbing riparian areas and possibly stranding fish in shallow areas as flows recede. The eight dams in the migration corridor of the Snake and Columbia Rivers kill or injure a portion of the smolts passing through the area. The low velocity at which water travels through the reservoirs behind the dams slows the smolts' journey to the ocean and enhances the survival of predatory fish (Independent Scientific Group 1996, National Research Council 1996). Formerly complex mainstem habitats in the Snake River have been reduced, for the most part, to single channels, with floodplains reduced in size, and off-channel habitats eliminated or disconnected from the main channel (Sedell and Froggatt 1984; Independent Scientific Group 1996; and Coutant 1999). The amount of large woody debris in the river has declined, reducing habitat complexity and altering the river's food webs (Maser and Sedell 1994).

Other human activities that have degraded aquatic habitats or affected native fish populations in the Snake River Basin include stream channelization, elimination of wetlands, construction of flood control dams and levees, construction of roads (many with impassable culverts), timber harvest, splash dams, mining, water withdrawals, unscreened water diversions, agriculture, livestock grazing, urbanization, outdoor recreation, fire exclusion/suppression, artificial fish propagation, fish harvest, and introduction of non-native species (Henjum *et al.* 1994; Rhodes *et al.* 1994; National Research Council 1996; Spence *et al.* 1996; and Lee *et al.* 1997). In many watersheds, land management and development activities have: (1) reduced connectivity (i.e., the flow of energy, organisms, and materials) between streams, riparian areas, floodplains, and uplands; (2) elevated fine sediment yields, degrading spawning and rearing habitat; (3) reduced large woody material that traps sediment, stabilizes streambanks, and helps form pools; (4) reduced vegetative canopy that minimizes solar heating of streams; (5) caused streams to become straighter, wider, and shallower, thereby reducing rearing habitat and increasing water temperature; (6) altered peak flow volume and timing, leading to channel changes and potentially altering fish migration behavior; and (7) altered floodplain function, water tables and base flows (Henjum *et al.* 1994; McIntosh *et al.* 1994; Rhodes *et al.* 1994; Wissmar *et al.* 1994; National Research Council 1996; Spence *et al.* 1996; and Lee *et al.* 1997).

Of particular significance to the subject consultation, the lower Snake River dams have substantially disrupted sediment transport within the river channel. As the Snake and Clearwater Rivers meet the slack water of Lower Granite Reservoir, bed load and suspended particles soon settle to the river bottom, resulting in a substantial accumulation of sediment near the head of the reservoir. The COE estimates that 2.6 million cubic yards of sediment enter Lower Granite Reservoir annually. Under the conditions of the environmental baseline, the existence and operation of the lower Snake River dams and reservoirs prevent the normative transport and deposition of this sediment. Without the dams, finer grained materials would tend to be deposited on the river floodplain or high along the channel margins and the riverbed would present a complex mosaic of substrate conditions along the length of the lower Snake River. Presently, there are few shallow water sandy shoals below the confluence area. Consequently, smolts, which feed during the seaward migrations, must travel substantial distances between foraging areas. There are also few accumulations of suitable spawning gravels (for fall chinook) except in the tailraces of the dams.

As mentioned in section 1.3, maintaining the Federal Navigation System through the lower Snake River reservoirs indirectly affects the subject ESUs by enabling habitat-affecting activities in the mainstem Snake River and upstream tributaries. As mentioned above in the present section, many of these upstream habitats are degraded, to the detriment of the subject ESUs. NOAA Fisheries is unable to determine the contribution of activities enabled by the Federal Navigation System to these habitat conditions and is accordingly unable to determine the extent to which the proposed action would contribute to further degrading these habitats. However, to address problems inhibiting salmonid recovery in Columbia River Basin tributaries, the Federal resource and land management agencies developed the *All H Strategy* (Federal Caucus 2000).

Components of the *All H Strategy* commit these agencies to increased coordination and swift action on protecting and restoring habitats.

The biological requirements of the listed species are not being met under the environmental baseline. Conditions in the action area would have to improve, and any further degradation of the baseline, or delay in improvement of these conditions would probably further decrease the likelihood of survival and recovery of the listed species under the environmental baseline.

Pacific salmon populations also are substantially affected by variation in the freshwater and marine environments. Ocean conditions are a key factor in the productivity of Pacific salmon populations. Stochastic events in freshwater (flooding, drought, snowpack conditions, volcanic eruptions, etc.) can play an important role in a species' survival and recovery, but those effects tend to be localized compared to the effects associated with the ocean. The survival and recovery of these species depends on their ability to persist through periods of low natural survival due to ocean conditions, climatic conditions, and other conditions outside the action area. Freshwater survival is particularly important during these periods because enough smolts must be produced so that a sufficient number of adults can survive to complete their oceanic migration, return to spawn, and perpetuate the species. Therefore it is important to maintain or restore habitat at or to properly functioning condition (PFC) in order to sustain the ESU through these periods. Additional details about the importance of freshwater survival to Pacific salmon populations can be found in Federal Caucus (2000), NMFS (2000), and Oregon Progress Board (2000).

2.2 Analysis of Effects

Effects of the action are defined as: "the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with the action, that will be added to the environmental baseline" (50 CFR 402.02). Direct effects occur at the project site and may extend upstream or downstream based on the potential for impairing the value of habitat for meeting the species' biological requirements or impairing the essential features of critical habitat. Indirect effects are defined in 50 CFR 402.02 as "those that are caused by the proposed action and are later in time, but still are reasonably certain to occur." They include the effects on listed species or critical habitat of future activities that are induced by the proposed action and that occur after the action is completed. "Interrelated actions are those that are part of a larger action and depend on the larger action for their justification" (50 CFR 402.02). "Interdependent actions are those that have no independent utility apart from the action under consideration" (50 CFR 402.02).

NOAA Fisheries evaluates the effects of proposed actions on listed species and seeks to answer the question of whether the species can be expected to survive with an adequate potential for recovery. In watersheds where critical habitat has been designated, NOAA Fisheries must make a separate determination of whether the action will result in the destruction or adverse modification of designated critical habitat (50 CFR 402.14).

NOAA Fisheries will consider any scientifically credible analytical framework for determining an activity's effect on the listed species. In order to streamline the consultation process and encourage more consistent effects determinations across agencies, NOAA Fisheries recommends that action agencies use the MPI and procedures in NMFS (1996), particularly when their proposed action would take place in forested montane environments. NOAA Fisheries is working on similar procedures for other environments. Regardless of the analytical method used, if a proposed action is likely to appreciably reduce the functioning of already impaired habitat, or retard the long-term progress of impaired habitat toward PFC, it might not be found consistent with conserving the species.

For the streams typically considered in salmon habitat-related consultations, a watershed is a logical unit for analysis of potential effects of an action (particularly for actions that are large in scope or scale). Healthy salmonid populations use habitats throughout watersheds (Naiman *et al.* 1992), and riverine conditions reflect biological, geological and hydrological processes operating at the watershed level (Nehlsen *et al.* 1997; Bisson *et al.* 1997; and NMFS 1999a).

The subject BA provides an analysis of the effects of the proposed action on SRF chinook, SRSS chinook and SR steelhead and their critical habitat in the action area. The analysis is based on the best scientific and commercial data available to evaluate elements of the proposed action that have the potential to affect the listed fish or essential features of their designated critical habitat.

2.2.1 Direct Effects

Direct effects result from the agency action and include the effects of interrelated and interdependent actions. Future Federal actions that are not direct effects of the action under consideration (and not included in the environmental baseline or treated as indirect effects) are not evaluated.

The direct effects of the proposed action would result from activities that would commence during the dredging season within which the proposed action is implemented. These activities include dredging and inwater dredged material disposal. The potentially significant direct effects of these activities include: (1) turbidity; (2) suspension of contaminants; (3) entrainment of juvenile salmonids; (4) loss or alteration of SRF spawning habitat; (5) loss or alteration of shallow water rearing habitat; and (6) filling of shallow water habitat.

Except where noted otherwise, this analysis concerns SRF chinook (eggs, embryos, or overwintering juveniles), SRSS chinook (overwintering juveniles), and steelhead (adults and overwintering juveniles). NOAA Fisheries is unaware of documentation that juvenile steelhead occupy the lower Snake River during the winter dredging season, but believes they will be present in small numbers.

2.2.1.1 Turbidity

Dredging and the inwater disposal of dredged materials would disturb and suspend a significant volume of benthic sediment. In the immediate vicinity of these activities, turbidity would likely substantially exceed natural background levels, potentially affecting listed fish species.

Quantifying turbidity levels, and their effect on fish species, is complicated by several factors. First, turbidity from an instream activity will typically decrease as distance from the activity increases. How quickly turbidity levels attenuate depends on the quantity of materials in suspension (e.g., mass or volume), the particle size of suspended sediments, the amount and velocity of ambient water (dilution factor), and the physical/chemical properties of the sediments. Second, the impact of turbidity on fishes is not only related to the turbidity levels, but also the particle size of the suspended sediments.

For salmonids, turbidity elicits a number of behavioral and physiological responses (i.e., gill flaring, coughing, avoidance, increase in blood sugar levels) which indicate some level of stress (Bisson and Bilby 1982; Sigler *et al.* 1984; Berg and Northcote 1985; Servizi and Martens 1992). The magnitude of these stress responses is generally higher when turbidity is increased and particle size decreased (Bisson and Bilby 1982; Servizi and Martens 1987; Gregory and Northcote 1993). Although turbidity may cause stress, Gregory and Northcote (1993) have shown that moderate levels of turbidity (35-150 NTU) accelerate foraging rates among juvenile chinook salmon, likely because of reduced vulnerability to predators (camouflaging effect).

When the particles causing turbidity settle from the water column, they contribute to sedimentation. Sedimentation can cause the following effects: (1) buried salmonid eggs or embryos may be smothered and suffocated; (2) prey habitat may be displaced; and (3) future spawning habitat may be displaced (Spence *et al.* 1996). In addition, turbidity and subsequent sedimentation can affect the quality of stream substratum as spawning material, influence the exchange of streamflow and shallow alluvial groundwater, depress riverine productivity, and contribute to decreased salmonid growth rates (Waters 1995; Newcombe and Jensen 1996).

The COE proposes the use of mechanical dredging, which involves excavating sediments with a clamshell, scoop, shovel, or other device. Mechanical dredging has the potential to create turbidity primarily where the excavation is occurring as the interface between the excavating apparatus and sediments is not contained. It is expected that turbidity resulting from dredging and dredged material disposal would be intense in the vicinity of the activity themselves, but would rapidly attenuate with time and space.

The COE would implement a number of techniques to minimize turbidity effects resulting from project operations. First, the COE would monitor turbidity levels and modify dredging operations to avoid prolonged negative effects (see section 1.2). Second, the COE would implement dredging and disposal operations during a period when listed salmonids are not abundant. While SRF chinook (eggs, embryos, and stream type juveniles), SRSS chinook (juveniles) and SR steelhead (adults and overwintering juveniles) would be present in the action area during this work window, the vast majority of individuals of these species and life stages will be upstream of the areas proposed for dredging and disposal. SRF chinook juveniles are likely to be more abundant than other species or life history stages during the proposed work window. Conner *et al.* (in review) estimate that up to 9% of all SRF chinook overwinter in Lower Granite Reservoir. However, few overwintering chinook are expected to be in the vicinity or dredging operations as these fish are pelagic, preferring water greater than 23 feet deep (William Conner, biologist Fish and Wildlife Service, January 9, 2004). Furthermore, SRF chinook are extremely unlikely to spawn near the Knoxway Canyon disposal site, the confluence area, or boat basin sites where dredging would be most likely to create significant turbidity events because conditions (*i.e.,* riverbed substrates and water velocities) are unsuitable for spawning. Third, the COE would dispose of silts in a manner to limit their exposure to listed fish by meeting water quality standards within not more than 300 feet downstream of the dredging area. Finally, the COE would use best management practices (BMPs) at disposal locations to prevent remobilization of sediments, and subsequent turbidity, through dewatering activities or storage.

2.2.1.2 Contaminants

Disturbing benthic sediments through dredging and inwater disposal could mobilize and distribute a variety of contaminants. The COE has identified PAHs, organophosphates, chlorinated herbicides, ammonia, oil, grease, glyphosate, AMPA, dioxin, heavy metals, and others as potential contaminants. Some of these contaminants may be acutely or chronically harmful to salmonids (Allan and Hardy 1980). However, many have unknown effects on salmonids or lack defined regulatory exposure criteria (Ewing 1999).

The degree to which contaminants would be suspended during dredging and inwater disposal, and the effects of the contaminants on listed salmonids are not clear. The COE has tested sediments for contaminants across all areas where dredging is proposed. The COE has not found contaminants in concentrations that exceed existing regulatory criteria. However, regulatory criteria have not been designated for all contaminants or life history events relevant to listed salmonids.

Another area of uncertainty is how dredging or inwater disposal actually distributes contaminants. If the dredging equipment contains the sediments effectively after excavation, the distribution of contaminants would be greatly minimized. Conversely, if contaminated sediments are not contained effectively, they could be widely distributed. This is the primary concern with inwater disposal activities. Inwater disposal would involve dumping sediments directly from a barge into the water, potentially re-suspending any contaminants present. The COE, however, has tested sediments within the action area and determined that they would not, with the exception of silty substrates, exceed existing regulatory thresholds for a range of contaminants. The COE has determined that most contaminants are bound to fine particulate sediments (e.g., silt) and, therefore, will limit the extent to which they are disposed inwater and will ensure that silts disposed inwater will be covered with a minimum ten-foot-thick mantle of sand.

If contaminants are released during dredging or disposal activities, their effects may be subtle and difficult to directly observe. The effects of bioaccumulation are of particular concern as pollutants can reach concentrations in higher trophic level organisms (e.g., salmonids) that far exceed ambient environmental levels (Allan and Hardy 1980). Bioaccumulation may therefore cause delayed stress, injury or death as contaminants are transported from lower trophic levels (e.g., benthic invertebrates or other prey species) to predators long after the contaminants have entered the environment or food chain. It follows that some organisms may be adversely affected by contaminants while regulatory thresholds for the contaminants are not exceeded during measurements of water or sediments.

Exposure to sublethal levels of contaminants might have serious implications for salmonid health and survival. Recent studies have shown that low concentrations of commonly available pesticides can induce significant sublethal effects on salmonids. Scholz *et al.* (2000) and Moore and Waring (1996) have found that diazinon interferes with a range of physiological biochemical pathways that regulate olfaction, adversely affecting homing, reproductive and anti-predator behavior of salmonids. Waring and Moore 1997 also found that the carbamate, carbofuran, had significant effects on olfactory mediated behavior and physiology in Atlantic salmon (*Salmo salar*). Ewing (1999) reviewed scientific literature on the effects of pesticides on salmonids and identified a wide range of sublethal effects: impaired swimming performance, increased predation on juveniles, altered temperature selection behavior, reduced schooling behavior, impaired migratory abilities, and impaired seawater adaptation.

Other non-pesticide compounds that are common constituents of urban pollution and agricultural runoff also adversely affect salmonids. Exposure to chlorinated hydrocarbons and aromatic hydrocarbons causes immunosuppression and increased disease susceptibility (Arkoosh *et al.* 1998). In areas where chemical contaminant levels are elevated, disease may reduce the health and survival of affected fish populations (Arkoosh *et al.* 1998). Throughout the lower Snake River, high concentrations of ammonia have been found in areas where fine sediments (silt) are prevalent (COE and EPA 2003). Because ammonia is so common in fine sediments, it is expected that ammonia would be a primary concern during dredging and disposal operations. Ammonia is toxic to fish, especially when the pH is relatively high (above 7.5) as is the case in the Snake River (COE and EPA 2003). However, ammonia does not have bioaccumulation potential common to fat soluble organic compounds.

As noted above, there is a growing body of literature that suggests small amounts of certain contaminants may affect the biology of salmonids. At present, regulatory thresholds are likely inadequate to account for these effects (i.e., some contaminants do not have salmonid exposure criteria or bioaccumulation criteria). It is expected that exposure criteria will be refined and expanded in the future.

In the meantime, the COE has committed to conservation measures that minimize the exposure of listed salmonids to contaminants: (1) the COE would conduct dredging and disposal activities during the winter when listed salmonids are not abundant. Of the listed ESUs, SRF chinook (eggs, embryos, and stream type juveniles), SRSS chinook (juveniles) and SR steelhead (adults and overwintering juveniles) would be present in the action area, but in low numbers relative to migration periods, during this work window; (2) the COE would continue to sample sediments for contaminants and refrain from disposing of contaminated sediments inwater; (3) the COE would use cleaner silts as a cap for the woody riparian bench and the silts (only those suitable for inwater disposal) deposited in association with the shallow water habitat feature will be capped with a ten-foot-thick mantle of sand; and (4) the COE would implement BMPs to prevent fuels spills, hydraulic leaks, etc. during dredging and disposal operations.

2.2.1.3 Entrainment and Harassment

Dredging devices have the potential to capture or entrain juvenile salmonids or embryos. Mechanical dredging is most likely to affect non-mobile salmonids (i.e., early life history stages). Previous dredging activities in the Snake River have resulted in entrainment of listed chinook; developing embryos and alevins were accidentally collected in a mechanical dredging operation that took place downstream of the Lower Monumental Dam in 1992 (COE 1992).

The COE has committed to a number of conservation measures to reduce the probability of entrainment occurring during future dredge operations. First, dredging activities would be accomplished using mechanical means. Mechanical dredging would minimize the risk posed to juveniles and adult steelhead, as free-swimming fishes should be able to escape the dredging device, even if temporarily entrained. Second, the COE has committed to thoroughly survey those portions of the area proposed for dredging where SRF chinook redds might occur (*i.e.*, near and within the navigation lock approaches) prior to dredging, and then dredge around or otherwise avoid any observed redds. Third, the COE would complete dredging operations in winter when listed salmonids are not expected to be abundant.

NOAA Fisheries believes the probability of entraining adult steelhead, juvenile SRF chinook, or juvenile SRSS chinook is very low because these fish are likely to avoid the immediate vicinity of dredging operations, and because dredging operations proceed slowly. Furthermore, NOAA Fisheries expects that these species will be only nominally affected by the act of avoiding dredging operations. The conservation measures to be implemented by the COE sufficiently address the situations where entrainment and harassment are likely to occur.

2.2.1.4 Alteration of SRF Chinook Spawning Habitat

As mentioned previously, the amount of SRF chinook spawning habitat was substantially reduced by the development of the Federal Columbia River hydropower system and other non-Federal dams on the Snake River. Only the dredging proposed at the Lower Granite and Lower Monumental Navigation Lock Approaches would occur near areas where SRF chinook spawning has been documented since the construction of the lower Snake River dams. SRF chinook spawning has been observed in the tailraces of the two dams, but not since 1994 (Dauble *et al.* 1995, 1996, and 1998, Mueller 2003). Furthermore, SRF chinook redds have not been observed within the dredging templates for the proposed action (Dauble *et al.* 1995, 1996, and 1998, Mueller 2003).

Dauble *et al.* (1998) evaluated SRF chinook spawning habitat suitability in the tailraces of the two dams. They characterized habitat suitability according to water depth, substrate particle size, riverbed slope, and water velocity, and found that small portions of the lock approaches (4% of the lock approach area at Lower Granite Dam and less than 1% of the lock approach area at Lower Monumental Dam), provided conditions suitable for SRF chinook spawning. They also observed that the portions of the tailraces near the discharges from the powerhouses contained substantially more suitable SRF chinook spawning than the lock approaches. Mueller (2003) concluded that water depth and substrate size at the two lock approaches were suitable for SRF chinook spawning, but riverbed slope and water velocity were not.

The effects of dredging to SRF chinook spawning habitat are expected to be insignificant because: (1) the lock approaches contain little suitable spawning habitat; (2) the COE proposes to dredge relatively small portions of lock approaches (4.3% and 13.1% at Lower Granite and Lower Monumental, respectively); (3) dredging will increase water depth and alter riverbed contours but will not alter the fundamental character of the riverbed (*i.e.*, the bed will still be formed of gravels and cobbles); and (4) there is no evidence that SRF chinook are inclined to spawn in the lock approaches.

2.2.1.5 Fill of Shallow Water Habitat

The Knoxway Canyon disposal site covers approximately 44 acres, most of which varies from 20 feet to 60 feet deep. Some shallow water habitat (less than 10 feet deep) exists here, but the riverbed in the area is almost uniformly silt (COE and EPA 2003), a substrate type not preferred by listed ESUs in the action area (Bennett *et al.*1997). The proposed disposal would be expected to improve shallow water habitat quality and quantity by decreasing water depth and riverbed slope near the shoreline, and covering silty substrates with sand.

While it is not certain that the created habitat would be used by juvenile salmonids, investigations by Bennett *et al.* (1997) suggest it would. They found substantial numbers of sub-yearling chinook occupying newly-created shallow water habitats at another site in the Lower Granite reservoir near RM 120. The durability of the habitat feature is also uncertain. It may be destroyed by wave action and other erosional processes, or it too may be smothered with silts. The COE proposes to monitor the feature and buttress the base with gravels and cobbles if needed. Furthermore, the channel encroachment created by the planting bench is expected to slightly increase local water velocities which should discourage the deposition of silts on the shallow substrates with larger, more preferred substrate particle sizes.

The short- and long-term effects of filling the small amount of shallow water habitat at the Knoxway Canyon site are expected to be insignificant because listed fish do not appear to be using the area (COE and EPA 2003). The creation of the shallow water bench and riparian area are expected to improve rearing habitat quantity and quality in the long term. Furthermore, the creation of the riparian planting bench is expected to contribute a more complex array of food items for juveniles of all Snake River ESUs over the long term.

2.2.1.6 Dredging Juvenile Rearing Habitat

As mentioned previously, SRF chinook and SRSS chinook are known to rear in the lower Snake River. As listed in Table 1, the COE proposes to dredge approximately 71.5 acres of silt and sand accumulations that occur at mid-depth (10-14 feet deep) and shallow (less than 10 feet deep) portions of the lower Snake River. These sites represent varying degrees of suitability as juvenile rearing habitat for the subject ESUs. Suitability is determined by depth, substrate type, and location relative to the shoreline. Bennett *et al.* (1997) found that subyearling chinook show a much greater affinity for sandy, shallow water habitats near shorelines than for any other habitat sampled.

The most important habitat attribute of the riverbed to listed ESUs in this portion of the Snake River is the production of food items for rearing and migrating juveniles. Oligachaetes and chironomids (dipterans) are the dominant juvenile chinook salmon and steelhead food items produced in the silty and sandy substrates in this area (Bennett and Shrier 1986, Curet 1994). Populations of these invertebrates are likely to be locally reduced immediately following dredging operations. However, as these species occupy habitat types that are prone to disturbance under natural conditions, they would likely rapidly recolonize dredged areas by drifting and crawling from adjacent non-disturbed areas (e.g., Mackay 1992).

Federal Navigation Channel at Confluence of Snake and Clearwater Rivers

The majority of the dredging of potential rearing habitat, 85% by volume and 88% by area, would occur within the Federal navigation channel in the confluence area. The riverbed within the navigation channel, which has been previously dredged several times, is composed mostly of sand, which is the type of rearing substrate preferred by subyearling chinook. However, the navigation channel is generally not near shorelines and is not therefore likely to be utilized by many subyearling chinook (Bennett *et al.* 1997).

The proposed dredging would affect approximately 12.5% of the shallow water habitat in the confluence area, but the areas nearer the shoreline would remain largely untouched. Even after dredging, the confluence area will contain the greatest concentration of shallow water rearing habitat in the lower Snake River. The proposed dredging sites within the navigation channel are presently 11 feet to 14 feet deep and would be dredged to depths of not more than 16 feet. The change in depth would not be expected to reduce the suitability of these habitats. Dredging would result in a more uniform riverbed, but the riverbed would still be covered with sands. As mentioned previously, dredging would reduce the abundance of food items in the confluence area in the year dredging occurs, but the effects to listed species are expected to be minor because invertebrate populations would be expected to recover quickly and because it is likely that listed species will find suitable foraging opportunities at the unaffected areas in the confluence.

Port Facilities

The COE proposes to dredge a total of 2.7 acres of previously dredged riverbed at the Ports of Lewiston and Clarkston. Dredging at these sites would occur near shorelines, but the affected portion of the riverbed is covered with silts which are generally avoided by juvenile salmonids. These sites would be dredged from present depths of 12-14 feet to maximum depths of 15 feet. Again, dredging would result in a more uniform riverbed, but the riverbed would still be covered with silts. As mentioned previously, dredging would reduce the abundance of food items in the confluence area in the year dredging occurs, but the effects to listed species are expected to be minor because invertebrate populations would be expected to recover quickly and because it is likely that listed species will find suitable foraging opportunities at the unaffected areas near port facilities.

Recreation Facilities

As listed in Table 1, the COE also proposes to dredge a total of 5.6 acres at several recreation facilities in the lower Snake River. Recent observations suggest significant use of these sites by juvenile chinook and some use by juvenile steelhead (COE and EPA 2003). Dredging at these sites would restore maximum depths of not greater than eight feet, and would not reduce the suitability at any site with regard to water depth (Bennett *et al.* 1997). Habitat suitability in terms of substrate composition would remain the same as before dredging operations. Because there are significant amounts of shallow water habitat at each site outside of the proposed dredging templates, the short-term loss of food items resulting from dredging is unlikely to significantly affect listed species.

As mentioned previously, the COE proposes to further minimize the effects of the proposed action to shallow water habitat by constructing nearshore rearing habitat near Knoxway Canyon. The goal of this habitat construction would be to provide shallow, sandy rearing conditions favored by juvenile chinook (Bennett *et al.* 1997). The creation of rearing habitat with dredged materials is intended to replace habitat functions lost as a result of dredging activities.

2.2.2 Indirect Effects

Indirect effects are caused by or result from the proposed action, are later in time, and are reasonably certain to occur (50 CFR 402.02). Indirect effects can occur outside of the area directly affected by the action. Indirect effects can include other Federal actions that have not undergone section 7 consultation but will result from the action under consideration. These actions must be reasonably certain to occur, or they are a logical extension of the proposed action. The indirect effects of the proposed dredging of the navigation channel are those effects to listed species and their habitat that result from activities enabled by the maintenance of the Federal navigation system on the lower Snake River.

Continuing anthropogenic sedimentation of the Snake River and many of its tributaries would likely be a significant indirect effect of the proposed action. Reckendorf and Pedone (1989) implicate erosion from forestry and agricultural practices as major contributors of sediment to the Snake and Clearwater Rivers. Much of the agricultural production in the Snake River basin is shipped to market through the Federal navigation system. Wheat, barley, wood chips, and other wood products are the primary commodities bound downstream while petroleum and fertilizer are the primary commodities bound upstream (COE and EPA 2001). These shipments depend on the availability of a navigation system that provides a 14-foot draft channel for barge tows (COE and EPA 2001, 2003).

The predominance of agricultural commodities (wheat, barley, fertilizer) in barge commerce indicates that this industry has strong economic interests in the maintenance of the navigation system. Barging appears to be a significant factor in determining the profitability of the major crops in the Snake River Basin. For instance, Jessup and Casavant (1998) determined that without river navigation above the Tri-Cities (at any time during the year), grain farmers and shippers would be adversely affected. In their analysis they compared scenarios where wheat and barley were transported using rail shipments instead of barge shipments. They estimated that transportation costs would increase, on average, 4.2 cents per bushel and 6.8 cents per bushel for wheat and barley, respectively. However, the cost increase would vary with some shippers experiencing little or no change in transportation costs and some shippers experiencing up to seven cents per bushel for wheat and 13 cents per bushel for barley.

Moving agricultural products solely by truck instead of barging would also increase transportation costs. Transporting a 47,000-pound container of lentils round-trip by truck between a load center in the Palouse and Portland's Terminal 6 costs approximately $800. Moving the same container between the same points via truck and barge combination costs approximately $350 (Ellis 1999). While we cannot assume that the agriculture industry exists solely because of the navigation system as it predated the installation of the mainstem dams on the Snake and Columbia Rivers. Agricultural production levels are probably affected by the cost of shipping products and supplies (Jessup and Casavant 1998).

In this consultation, agricultural land use is particularly relevant to dredging because it is one of the primary causes of sedimentation which, leading to the chronic need for frequent dredging. The COE and EPA (2003) estimate that 2.6 million cubic yards of sediment enter the Lower Granite reservoir annually. Reckendorf and Pedone (1989) implicated agricultural land use in the Clearwater, Grande Ronde, and Salmon River Basins as major anthropogenic sources of sediments. Furthermore, agricultural practices have contributed to declines in stream flows and riparian conditions throughout the Snake River Basin (Busby *et al.* 1996) affecting the productivity of the subject ESUs.

While the COE's actions may enable habitat-affecting land uses, those uses are beyond the COE's authority to regulate. The COE is pursuing congressional authority and appropriations for a basin-wide study to identify and evaluate significant sources of sediment in the lower Snake River. The study will be used to formulate and evaluate approaches for reducing sediment delivery with a goal of reducing the need for dredging. Other Federal agencies, the Natural Resource Conservation Service and the Farm Service Agency for example, may be able to use their authorities, based on the results of this study, to assist in reducing agricultural effects to listed species in the Snake River Basin.

2.2.3 Species Effects

As described in section 2.1.2, NOAA Fisheries has estimated the median population growth rate (lambda) for each species potentially affected by the implementation of the proposed dredging. Based on the effects described above, NOAA Fisheries believes that the proposed action would have a neutral effect on the survival and recovery of SR steelhead, SRSS chinook, or SRF chinook.

2.2.4 Cumulative Effects

Cumulative effects are defined in 50 CFR 402.02 as "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation." These activities within the action area also have the potential to adversely affect the listed species and critical habitat. Future Federal actions, including the ongoing operation of hydropower systems, hatcheries, fisheries, and land management activities are being reviewed through separate section 7 consultation processes. Federal actions that have already undergone section 7 consultations have been added to the description of the environmental baseline in the action area.

Throughout the action area, much of the land is likely to remain rural and to be used for agricultural purposes. However, most arable lands have been developed and water resource development has slowed in recent years. Increasing environmental regulations and diversification in local economies has reduced some impacts that have been previously associated with water and land use by agriculture and extractive industries.

The State of Washington has also implemented a number of strategies to improve habitat for listed species. The 1998 Salmon Recovery Planning Act provided the framework and a funding mechanism for developing watershed restoration projects. It also created the Governor's salmon Recovery Office to coordinate and assist in the development of salmon recovery plans. Washington's "Statewide Strategy to Recover Salmon," for example, is designed to improve watersheds (NMFS 2000).

The Watershed Planning Act, also passed in 1998, encourages voluntary planning by local governments, citizens, and Tribes for water supply and use, water quality, and habitat at the Water Resource Inventory Area or multi-Water Resource Inventory Area level. Grants are made available to conduct assessments of water resources and to develop goals and objectives for future water resources management. The Salmon Recovery Funding Act established a board to prioritize local salmon restoration funding. The board will deliver funds for salmon recovery projects and activities (NMFS 2000).

Washington's Department of Fish and Wildlife and tribal co-managers have been implementing the Wild Stock Recovery Initiative since 1992. The co-managers are completing comprehensive species management plans that examine limiting factors and identify needed habitat activities. The plans also concentrate on actions in the harvest and hatchery areas, including comprehensive hatchery planning. The department and some western Washington treaty Tribes have also adopted a wild salmonid policy to provide general guidance to managers on fish harvest, hatchery operations, and habitat protection and restoration measures to better protect wild salmon runs (NMFS 2000).

Water quality improvements may result from the development of total maximum daily load restrictions (TMDL) for a range of pollutants. The state of Washington is under court orders to develop TMDL management plans for each water body listed as water quality limited under Section 303 (d) of thee Clean Water Act. It has developed a schedule that is updated yearly; the schedule outlines the priority and timing of TMDL plan development (NMFS 2000).

The state of Washington established and funds a program to lease or buy water rights for instream flow purposes. This program began in 2000 and is in the preliminary stages of public information and identification of potential acquisitions. These water programs, if carried out over the long term, should improve water quantity and quality in the state (NMFS 2000). However, there is significant pressure within the state to begin appropriating water directly from the Columbia and Snake Rivers and from local aquifers that may be hydraulically connected to the Columbia. Furthermore, although the state withdrew the water of the mainstem Columbia and Snake Rivers from further appropriation in 1995, it reopened these rivers for further appropriation in 2002. Within this paradoxical dynamic, it is difficult to predict long-term trends in water quantity and quality.

Economic diversification has contributed to population growth and movement, and this trend is likely to continue. Such population trends will result in greater overall and localized demands for electricity, water, and buildable land in the action area; will affect water quality directly and indirectly; and will increase the need for transportation, communication, and other infrastructure. These economic and population demands will probably affect habitat features such as water quality and quantity, which are important to the survival and recovery of the listed species. Unless planning includes measures to avoid, minimize, and effectively mitigate the potential effects to listed species, the effect of continued growth and economic diversification will likely be negative.

2.2.5 Consistency with Listed Species ESA Recovery Strategies

Recovery is defined by NOAA Fisheries regulations (50 CFR 402) as an "improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4 (a)(1) of the Act." Recovery planning is underway for listed Pacific salmon in the Northwest with technical recovery teams identified for each domain. Recovery planning will help identify measures to conserve listed species and increase the survival of each life stage. NOAA Fisheries also intends that recovery planning identify the areas/stocks most critical to species conservation and recovery and thereby evaluate proposed actions on the basis of their effects on those areas/stocks.

Until the species-specific recovery plans are developed, the FCRPS Opinion and the related December 2000 *Memorandum of Understanding Among Federal Agencies Concerning the Conservation of Threatened and Endangered Fish Species in the Columbia River Basin* (together these are referred to as the Basinwide Salmon Recovery Strategy) provides the best guidance for judging the significance of an individual action relative to the species-level biological requirements. In the absence of completed recovery plans, NOAA Fisheries strives to ascribe the appropriate significance to actions to the extent available information allows. Where information is not available on the recovery needs of the species, either through recovery planning or otherwise, NOAA Fisheries applies a conservative substitute.

The COE has specific commitments to uphold under the Basinwide Salmon Recovery Strategy. Of particular significance in this consultation is the COE's responsibility to operate the lower Snake River dams at minimum operating pool (MOP) during the juvenile out-migration. The proposed dredging would enable holding these reservoirs at MOP without disrupting shipping commerce. The proposed action is consistent with the COE's responsibilities under the Basinwide Salmon Recovery Strategy.

2.3 Conclusions

NOAA Fisheries' jeopardy analysis is based upon the present status of the species, the effects of the environmental baseline within the action area, the effects of the proposed action, and cumulative effects. The analysis takes into account the species' status and the effects of baseline conditions because determining the effect of the action and future cumulative effects upon a species' status allows for determining the likelihood of survival and recovery. Depending on the specific considerations of the analysis, actions that are found likely to impair presently properly functioning habitat, appreciably reduce the functioning of already impaired habitat, or retard the long-term progress of impaired habitat towards properly functioning condition at the population or ESU scale will generally be determined likely to jeopardize the continued existence of listed salmon, adversely modify critical habitat, or both. Specific considerations include whether habitat condition was an important factor for the decline in the listing decision, changes in population or habitat conditions since listing, and any new information that has become available.

2.3.1 Critical Habitat Conclusion

NOAA Fisheries designates Critical Habitat for a listed species based upon physical and biological features that are essential to that species. Essential features of Critical Habitat for threatened SRF chinook, and threatened SRSS chinook, include substrate, water quality/quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions (December 28, 1993, 58 Fed. Reg. 68543).

The proposed action would cause transient effects on Critical Habitat, as described above. Turbidity and the resuspension of contaminants, will occur largely concurrent with and local to dredging and inwater disposal activities. The proposed action would also reduce the availability of food items during the spring and summer following dredging. Longer term adverse effects are not anticipated. The COE proposes to create shallow water and riparian habitat that would be expected to improve food abundance, diversity, and distribution as early as the year following dredging.

As mentioned previously, SRF chinook spawning has not been documented within the navigation lock approaches, even in recent years when SRF returns to the Snake River have been fairly large. While the navigation lock approaches contain substrate sizes suitable for spawning, it appears that the riverbed slope and current velocities at these locations make them unsuitable for spawning. Dredging in the navigation lock approaches will remove gravel of appropriate size for redd construction but suitably sized gravels will remain even in the dredged areas. The navigation lock approaches do not appear to contain all of the essential features of SRF chinook spawning habitat. Furthermore, dredging as proposed in the present action is not likely to further diminish their suitability as spawning habitat or prevent them from becoming suitable.

Dredging might have an indirect influence on sedimentation by helping to maintain the economic viability of industries whose land use practices cause high levels of anthropogenic sedimentation. The COE is pursuing authorization and appropriations to study sediment sources and develop alternative sediment management strategies.

After reviewing the current condition of the critical habitat, factoring the effects on listed ESUs from the environmental baseline for the action area, the effects of the proposed action, and cumulative effects in the action area, it is NOAA Fisheries' opinion that the proposed action is not likely to destroy or adversely modify designated critical habitat of SRF chinook or SRSS chinook. The proposed action should not degrade baseline habitat functions necessary for the survival and recovery of any of the subject species. The action would cause transitory turbidity and would mobilize contaminants, but these effects would not affect long-term baseline habitat functions.

2.3.2 Species Conclusion

After reviewing the current status of the subject ESUs, and factoring affects from the environmental baseline for the action area, the effects of the proposed action, and cumulative effects in the action area, it is NOAA Fisheries' opinion that the proposed action is not likely to jeopardize the continued existence of SRF chinook, SRSS chinook, or SR steelhead. The COE would routinely monitor water quality during dredging operations, and would modify or suspend dredging operations as needed to ensure compliance with water quality standards. Existing regulatory thresholds are probably inadequate to account for the range of contaminant-related impacts that may affect listed salmonids in the action area. However, the species and life stages that would likely be present near dredging and disposal areas would be capable of avoiding injury or death by exiting these areas.

Overall, the direct and indirect effects attributable to the proposed action are not expected to degrade the environmental baseline to the extent that the survival and recovery of listed salmonids would be compromised. Despite the effects described above, the proposed action is unlikely to influence present population trends or risks. Accordingly, at no time, and without contingencies, will the activities described in this Opinion cause levels of take or destroy habitat that would appreciably reduce the likelihood of survival and recovery of the subject listed species.

2.4 Conservation Recommendations

Conservation recommendations are defined as "discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information" (50 CFR 402.02). Section 7 (a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the conservation of the threatened and endangered species. The conservation recommendations listed below are consistent with these obligations, and therefore should be implemented by the COE.

1. The COE should, in cooperation with other Federal agencies with applicable authorities or programs, encourage efforts to reduce sedimentation in the Snake River Basin.

2. The COE should investigate and pursue opportunities to enhance SRF chinook spawning habitat in the Snake River.

3. The COE should further investigate and pursue opportunities to enhance shallow water rearing habitat.

In order for NOAA Fisheries to be kept informed of actions minimizing or avoiding adverse effects, or those that benefit listed species or critical habitat, NOAA Fisheries requests notification of the achievement of any conservation recommendations when the action agency submits its monitoring report describing action under this Opinion or when the project is completed

2.5 Reinitiation of Consultation

As provided in 50 CFR 402.16, reinitiation of formal consultation is required if: (1) The amount or extent of taking specified in the Incidental Take Statement is exceeded, or is expected to be exceeded; (2) new information reveals effects of the action may affect listed species in a way not previously considered; (3) the action is modified in a way that causes an effect on listed species that was not previously considered; (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease, pending conclusion of the reinitiated consultation.

2.6 Incidental Take Statement

The ESA at section 9 (16 U.S.C. 1538) prohibits take of endangered species. The prohibition of take is extended to threatened anadromous salmonids by section 4(d) rule (50 CFR 223.203). Take is defined by the statute as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." (16 U.S.C. 1532(19)) Harm is defined by regulation as "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavior patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering." (50 CFR 222.102) Harass is defined as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering." (50 CFR 17.3) Incidental take is defined as "takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant." (50 CFR 402.02) The ESA at section 7(o)(2) removes the prohibition from any incidental taking that is in compliance with the terms and conditions specified in a section 7(b)(4) incidental take statement (16 U.S.C. 1536).

An incidental take statement specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary to minimize impacts and sets forth terms and conditions with which the action agency must comply in order to implement the reasonable and prudent measures.

2.6.1 Amount or Extent of Take

As stated in section 1.3, SRF chinook use the action area for migration, rearing, and spawning habitat. The SRSS chinook use the area for migration and some rear there. The SR steelhead use the area for migration and some adults overwinter there. These species are likely to be present in the action area when the effects of proposed dredging would occur. Therefore, incidental take of these listed fish is reasonably certain to occur. The proposed action includes measures to reduce the likelihood and amount of incidental take. To ensure the action agency carries out these measures, take minimization measures included as part of the proposed action are restated in the Terms and Conditions provided below.

As a general matter, take caused by the proposed action is likely in the form of harm, where habitat modification will impair normal behavior patterns of listed salmonids. Harm is likely to result from short-term decreases in water quality and food availability. For SRSS chinook and SR steelhead, the amount of take from these causes is difficult, if not impossible to estimate. In instances where the number of individual animals to be taken cannot be reasonably estimated, NOAA Fisheries uses a surrogate approach. The surrogate should provide an obvious threshold which, if exceeded, would provide a basis for reinitiating consultation.

This Opinion analyzes the extent of effects that would result from dredging and inwater disposal of dredged material. Despite the use of the best scientific and commercial data available, NOAA Fisheries cannot estimate the number of SRSS chinook or SR steelhead that would be injured or killed by these actions. Therefore, the extent of take exempted in this statement is that which would occur from dredging up to 79.06 acres of the bed of the Snake River, to a depth of not more than 16 feet within the navigation channel, not more than 15 feet at either port facility, and not more than 8 feet at any recreational facility. In addition, take resulting from water quality effects within 300 feet of dredging and disposal operations is authorized. Take is also exempted for covering up to 44 acres of the riverbed at the Knoxway Canyon disposal site, provided the spoils are shaped in a manner to maximize their value as juvenile salmonid rearing and foraging habitat.

Some data are available that enable a very crude estimate of the likely extent of take of individual fall chinook. Conner *et al.* (in review) estimated that approximately 9% of all SRF chinook juveniles that pass Lower Granite Dam overwinter in that reservoir. From 1985 through 1998 fewer than 250,000 juvenile SRF chinook passed the dam annually. Since that time, hatchery production of SRF chinook upstream of Lower Granite has expanded significantly and NOAA Fisheries estimates annual juvenile SRF chinook passage at Lower Granite Dam at up to 2.5 million. While Conner *et al.* made their observations in 1997 and 1998, before hatchery production was increased, NOAA Fisheries believes that it is likely that a comparable percentage of fall chinook will continue to overwinter in the reservoir. It is therefore likely that fewer than 250,000 juvenile SRF chinook will be in the reservoir during the proposed work window.

As mentioned previously, overwintering SRF chinook are pelagic and are not likely to be present near the shallow water dredging sites (William Connor, biologist, Fish and Wildlife Service, January 9, 2004), although they may be in the vicinity of the Knoxway Canyon disposal site. In total, the footprint of dredging and disposal operations entails approximately 1.3% of the area of Lower Granite Reservoir. If it is conservatively assumed that SRF chinook are 50% as likely to occupy dredging sites as they are to occupy deeper water habitats, that they are just as likely to occupy the Knoxway Canyon disposal site as all other sites within the reservoir, and that 50% of the fish present in dredging and disposal areas remain in these areas during dredging and disposal operations, then up to 1,112 juvenile SRF chinook, or 0.04% of the estimated juvenile population, could be affected by dredging and disposal operations. In addition to the take exemptions provided above, take of up to 1,112 juvenile SRF chinook in the form of harm from short-term decreases in water quality is also exempted.

2.6.2 Reasonable and Prudent Measures

Reasonable and Prudent Measures (RPMs) are non-discretionary measures to minimize take, that may or may not already be part of the description of the proposed action. They must be implemented as binding conditions for the exemption in section 7(o)(2) to apply. The COE has the continuing duty to regulate the activities covered in this incidental take statement. If the COE fails to adhere to the terms and conditions of the incidental take statement, or fails to retain the oversight of its contractor(s) to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

NOAA Fisheries believes that the following reasonable and prudent measures are necessary and appropriate to minimize take of SRF chinook, SRSS chinook, and SR steelhead resulting from implementation of the action. These reasonable and prudent measures would also minimize adverse effects on designated critical habitat for SRF chinook and SRSS chinook.

1. The COE will minimize take from dredging operations.

2. The COE will minimize take from disposal operations.

3. The COE will minimize take by monitoring.

4. The COE will minimize take by improving the available science regarding anthropogenic

sedimentation of the lower Snake River.

2.6.3 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the action must be implemented in compliance with the following terms and conditions, which implement the reasonable and prudent measures described above for each category of activity. These terms and conditions are non-discretionary.

Implement RPM No. 1 by conducting the following:

1.1 Dredging may commence no earlier than December 15 and may conclude not later than March 1.

1.2 Dredging must be concluded in a single dredging season.

1.3 Dredging at lock approaches will only occur after they have been surveyed for redds. If SRF chinook redds are discovered, the COE will notify NOAA Fisheries and the two agencies will jointly determine whether it is best to avoid the redds or delay dredging until juveniles have emerged. If the surveys are inconclusive, because of environmental conditions or other factors, dredging will be postponed until a definitive survey can be made.

1.4 Dredging operations will not violate water quality standards.

2. Implement RPM No. 2 by conducting the following:

2.1 Inwater disposal may commence no earlier than December 15 and may conclude not later than March 1.

2.2 Inwater disposal must be concluded in a single dredging season.

2.3 Disposal operations will not cause violations of water quality standards.

2.4 Inwater disposal will only occur at the Knoxway Canyon site. Material will be disposed in a manner to maximize its suitability as rearing habitat.

2.5 Material that contains concentrations of contaminants in excess of regulatory thresholds will be disposed of at an appropriate upland location.

3. Implement RPM No. 3 by conducting the following:

3.1 In accordance with the project description provided in section 1.2, water quality and sediment contaminant monitoring will be performed in accordance with the

Lower Columbia River Dredged Material Evaluation Framework (DMEF) (COE *et al* 1998).

3.2 In areas where contaminant analyses have yet to be performed, a randomized, non-biased sampling design will be implemented for sample collection. In accordance with the joint EPA/COE guidance presented in the DMEF, tier I and tier II procedures will be used to determine where samples will be collected. The COE will report the results of this sampling effort to NOAA Fisheries prior to the commencement of dredging operations.

3.3 The COE will evaluate the benefits of newly constructed habitat/inwater disposal sites. Specifically, the COE will determine if new habitat locations function as rearing habitat for juvenile fall chinook and will annually report the results of this evaluation to NOAA Fisheries.

3.4 If the COE or its contractor observes that a threatened or endangered species has been entrained by dredging operations, every reasonable attempt will be made to return the specimen safely back to the river. If a sick, injured, or dead specimen of a threatened or endangered species is observed, the finder must notify the Vancouver Field Office of NOAA Fisheries Law Enforcement at (360)418-4246. The finder must take care in handling sick or injured specimens to ensure effective treatment, and in handling dead specimens to preserve biological material in the best possible condition for later analysis of cause of death. The finder also has the responsibility to carry out instructions provided by Law Enforcement to ensure that evidence intrinsic to the specimen is not disturbed unnecessarily.

4. Implement RPM No. 4 by conducting the following

4.1 The COE will continue to pursue authorization and appropriations to study the sources of sediment entering the lower Snake River. The COE will use the results of this study as warranted to develop and implement strategies to reduce sedimentation.

3.0 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

3.1 Statutory Requirements

The MSA, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance EFH for those species regulated under a Federal fisheries management plan.

Pursuant to the MSA:

- Federal agencies must consult with NOAA Fisheries on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (section 305(b)(2)).

- NOAA Fisheries must provide conservation recommendations for any Federal or state action that may adversely affect EFH (section 305(b)(4)(A));

- Federal agencies must provide a detailed response in writing to NOAA Fisheries within 30 days after receiving EFH conservation recommendations. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NOAA Fisheries EFH conservation recommendations, the Federal agency must explain its reasons for not following the recommendations (section 305(b)(4)(B)).

The EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (MSA section 3). For the purpose of interpreting this definition of EFH: Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle (50 CFR 600.10). Adverse effect means any impact which reduces quality and/or quantity of EFH, and may include direct (*e.g.*, contamination or physical disruption), indirect (*e.g.*, loss of prey or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810).

The EFH consultation with NOAA Fisheries is required for any Federal agency action that may adversely affect EFH, including actions that occur outside EFH, such as certain upstream and upslope activities.

The objectives of this EFH consultation are to determine whether the proposed action may adversely affect designated EFH and to recommend conservation measures to avoid, minimize, or otherwise offset potential adverse effects on EFH.

3.2 Identification of Essential Fish Habitat

Pursuant to the MSA the Pacific Fishery Management Council (PFMC) has designated EFH for three species of Federally-managed Pacific salmon: chinook, coho (*O. kisutch*), and Puget Sound pink salmon (*O. gorbuscha*) (PFMC 1999). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the PFMC 1999), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years). Detailed descriptions and identifications of EFH for salmon are found in Appendix A to

Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). Assessment of potential adverse effects to these species' EFH from the proposed action is based, in part, on this information.

3.3 Proposed Actions

The proposed action and action area are detailed above in sections 1.2 and 1.3 of this document. The action area includes habitats that have been designated as EFH for various life-history stages of chinook and coho salmon.

3.4 Effects of Proposed Action on Essential Fish Habitat

The effects on EFH for chinook and coho are the same as those for ESA listed species and are described in detail in section 2.2.1 of this document, the proposed action may result in short- and long-term adverse effects on a variety of habitat parameters. These adverse effects are:

1. Dredging and disposal operations will suspend sediments and contaminants during operations and for a short time thereafter.

2. Salmonid food abundance will be locally reduced during the spring and summer following dredging.

3. Maintaining the navigation channel will contribute to anthropogenic sedimentation of the lower Snake River and EFH upstream.

3.5 Conclusion

NOAA Fisheries concludes that the proposed action may adversely affect designated EFH for chinook and coho salmon.

3.6 Essential Fish Habitat Conservation Recommendations

Pursuant to section 305(b)(4)(A) of the MSA, NOAA Fisheries is required to provide EFH conservation recommendations to Federal agencies regarding actions that may adversely affect EFH. NOAA Fisheries understands that the conservation measures described in the BA will be implemented by the COE, and believes that these measures are sufficient to minimize, to the maximum extent practicable, effects to EFH for chinook and coho salmon. Although, these conservation measures are not sufficient to fully address the remaining adverse effects to EFH, specific Terms and Conditions outlined in section 2.6.3 are generally applicable to designated EFH for chinook and coho salmon and do address these adverse effects. Consequently, NOAA Fisheries recommends that the following terms and conditions be implemented as EFH conservation measures.

1. Terms and Conditions Nos.1.2, 1.4, 2.2, 2.3, and 2.5 will minimize effects to water quality.

2. Terms and Conditions Nos. 2.4 and 3.3 will minimize effects to food abundance.

3. Term and condition No. 4.1 will minimize effects from anthropogenic sedimentation.

3.7 Statutory Response Requirement

Pursuant to the MSA (section 305(b)(4)(B)) and 50 CFR 600.920(j), Federal agencies are required to provide a detailed written response to NOAA Fisheries' EFH conservation recommendations within 30 days of receipt of these recommendations. The response must include a description of measures proposed to avoid, mitigate, or offset the adverse impacts of the activity on EFH. In the case of a response that is inconsistent with the EFH conservation recommendations, the response must explain the reasons for not following the recommendations, including the scientific justification for any disagreements over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects.

3.8 Supplemental Consultation

The COE must reinitiate EFH consultation with NOAA Fisheries if the proposed action is substantially revised in a manner that may adversely affect EFH, or if new information becomes available that affects the basis for NOAA Fisheries' EFH conservation recommendations (50 CFR 600.920(l)).

4.0 REFERENCES

Allen, K. O. and J. W. Hardy. 1980. Impacts of navigational dredging on fish and wildlife: a literature review. Office of Biological Sciences, Fish and Wildlife Service. Washington D.C.

Arkoosh, M. R., E. Casillas, E. Clemons, A. N. Kagley, R. Olson, and P. Reno. Effect of pollution on fish diseases: potential impacts to salmonid populations. J. Aquat. Anim. Health. 10: 182-190.

Bennett, D. H., and F. C. Shrier. 1986. Effects of sediment dredging and inwater disposal on fishes in Lower Granite Reservoir, Idaho-Washington. Annual Report to the U.S. Army Corps of Engineers, Walla Walla District. College of Fish and Wildlife, University of Idaho, Moscow.

Bennett, D. H., T. J. Dressser, Jr. and M. Madsen. 1997. Habitat use, abundance, timing, and factors related to the abundance of subyearling chinook salmon rearing along the shorelines of lower Snake River reservoirs. Completion Report to the U. S. Army Corps of Engineers, Walla Walla District. College of Fish and Wildlife, university of Idaho, Moscow.

Bennett, D.H., M. Madsen, S.M. Anglea, T. Chichosz, T.J. Dresser, Jr., M. Davis, S.R. Chipps. 1999. Fish interactions in Lower Granite Pool, Idaho-Washington. Completion Report to the U.S. Army Corps of Engineers, Walla Walla District. College of Fish and Wildlife, University of Idaho, Moscow.

Berg, L., and T. G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (Oncorhynchus kisutch) following short-term pulses of suspended sediment. Can. J. Fish. Aquat. Sci. 42: 1410-1417.

Bisson, P. A., and R. E. Bilby. 1982. Avoidance of suspended sediment by juvenile coho salmon. N. Am. J. Fish. Manage. 4: 371-374.

Bisson, P. A., G. H. Reeves, R. E. Bilby and R. J. Naiman. 1997. Watershed Management and Pacific Salmon: Desired Future Conditions. P. 447-474. In: Stouder, D.J., P.A. Bisson, and R.J. Naiman, eds. Pacific Salmon and Their Ecosystems: Status and Future Options. Chapman and Hall, New York.

Bjornn, T.C.s P.J. Keniry, K.R. Tolotti, J.P. Hunt, R.R. Ringe, C.T. Boggs, T.B. Horton, and C.A. Peery. 2003. Migration of adult steelhead past dams and through reservoirs in the lower Snake River and into the tributaries, 1991-1995. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho. 93pp.

Bugert, R., P. LaRiviere, D. Marbach, S. Martin, L. Ross, and D. Geist. 1990. 1989 Annual Report of Lower Snake River Compensation Plan, Salmon Hatchery Evaluation Program, to U.S. Fish and Wildlife Service (Cooperative Agreement 14-16-0001-89525).

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of West Coast steelhead from Washington, Idaho, Oregon, and California. NOAA Tech. Memo. NMFS-NWFSC-27, 261 p.

Busack, C. 1991. Genetic evaluation of the Lyons Ferry Hatchery stock and wild Snake River fall chinook. Washington Department of Fisheries, Report to ESA Administrative Record for Fall Chinook Salmon, Olympia. May.

Chapman, D., A. Giorgi, M. Hill, A. Maule, S. McCutcheon, D. Park, W. Platts, K. Prat, J. Seeb, L. Seeb, and others. 1991. Status of Snake River chinook salmon. Don Chapman Consultants, Inc., Boise, Idaho, for Pacific Northwest Utilities Conference Committee.

Conner, W.P. 2004. Biologist, Fish and Wildlife Service. Personal Communication.

Conner, W.P., K.F. Tiffan, J.G. Sneva, D. Ross, and R.K. Steinhorst. In review. The occurrence and extent of reservoir overwintering by juvenile fall chinook salmon in the Snake River. Transactions of the American Fisheries Society.

Corps of Engineers (COE). 1992 Completion of dredging for barge approach lane for lower Monumental permanent juvenile fish facility. Supplemental Biological Assessment. Corps, Walla Walla District, Walla Walla, Washington.

Corps of Engineers (COE), Environmental Protection Agency (EPA), Washington Department of Ecology (WDOE), Oregon Department of Environmental Quality(ODEQ), and Washington Department of Natural Resources(WDNR). 1998. Dredged Material Evaluation Framework: Lower Columbia River Management Area. Corps, Portland District, Portland Oregon.

Corps of Engineers (COE) and Environmental Protection Agency (EPA). 2001. Draft Walla Walla District Dredged Material Management Plan and Environmental Impact Statement for McNary Reservoir and Lower Snake Reservoirs. Draft Environmental Impact Statement. Corps, Walla Walla District, Walla Walla, Washington.

Corps of Engineers (COE). 2002. Dredged Material Management Plan and Environmental Impact Statement for McNary Reservoir and Lower Snake Reservoirs. Addendum B to the Biological Assessment. Corps, Walla Walla District, Walla Walla, Washington.

Corps of Engineers (COE) and Environmental Protection Agency (EPA). 2003. Supplemental Environmental Analysis for Purposes of 2003-2004 Dredging. Corps, Walla Walla District, Walla Walla, Washington.

Coutant, C.C. 1999. Perspectives on Temperature in the Pacific Northwest's Fresh Waters. Environmental Sciences Division Publication 4849 (ORNL/TM-1999/44), Oak Ridge National Laboratory, Oak Ridge, Tennessee. 108 p.

Curet, T. S. 1994. Habitat use, food habits and the influence of predation on subyearling chinook salmon in Lower Granite and Little Goose reservoirs, Washington. Master's Thesis. University of Idaho, Moscow.

Dauble, D. D., R. L. Johnson, R. P. Mueller, and C. S. Abernathy. 1995. Surveys of fall chinook salmon spawning areas downstream of lower Snake River hydroelectric projects, 1994-1995 season. Prepared for the U.S. Army Corps of Engineers, Walla Walla District by Batelle, Pacific Northwest Laboratory, Richland, Washington.

Dauble, D.D., R.L. Johnson, R.P. Mueller, W.H. Mavros, and C.S. Abernathy. 1996. Surveys of fall chinook salmon spawning areas downstream of lower Snake River hydroelectric projects, 1995-1996 season. Prepared for the U.S. Army Corps of Engineers, Walla Walla District by Batelle, Pacific Northwest Laboratory, Richland, Washington.

Dauble, D.D., R.L. Johnson, R.P. Mueller, and C.S. Abernathy. 1998. Surveys of fall chinook salmon spawning areas downstream of lower Snake River hydroelectric projects. Prepared for the U.S. Army Corps of Engineers, Walla Walla District by Batelle, Pacific Northwest Laboratory, Richland, Washington.

Ellis, A. 1999. Portland's marine exports chiefly agricultural. Portside. Summer 1999:11.

Ewing, R. D. 1999. Diminishing Returns: Salmon Decline and Pesticides. Oregon Pesticide Education Network. http://www.pond.net/~fish1ifr/salpest.pdf.

EPA (Environmental Protection Agency). 1999. Update of Ambient Water Quality Criterai for Ammonia. Office of Water and Office of Science and Technology , Washington D.C., and Office of Research and Development, Mid-Continent Ecology Division, Duluth, Minnesota. December 1999.

Federal Caucus. 2000. Conservation of Columbia Basin Fish: Final Basinwide Salmon Recovery Strategy. <http://www.salmonrecovery.gov> December.

Fulton, L. A. 1968. Spawning areas and abundance of chinook salmon, Oncorhynchus tshawytscha, in the Columbia River basin – past and present. U.S. Fish and Wildlife Service, Special Scientific Report, Fisheries 571:26.

Gregory, R. S., and T. S. Northcote. 1993. Surface, planktonic, and benthic foraging by juvenile chinook salmon (Oncorhynchus tshawytscha) in turbid laboratory conditions. Can. J. Fish. Aquat. Sci. 50: 223-240.

Healey, M. C. 1983. Coastwide distribution and ocean migration patterns of stream- and ocean-type chinook salmon, Oncorhynchus tshawytscha. Canadian Field-Naturalist 97:427-433.

Healey, M.C. 1991. Life history of chinook salmon (Oncorhynchus tshawytscha). Pages 311-393 in Groot, C. and L. Margolis, editors. Pacific salmon life histories. University of British Columbia Press, Vancouver, B.C.

Henjum, M.G., J.R. Karr, D.L. Bottom, D.A. Perry, J.C. Bednarz, S.G. Wright, S.A. Beckwitt and E. Beckwitt. 1994. Interim Protection for Late-successional Forests, Fisheries and Watersheds. National Forests East of the Cascade Crest, Oregon and Washington. A Report to the United States Congress and the President. The Wildlife Society, Bethesda, MD.

Independent Scientific Group. 1996. Return to the River: Restoration of Salmonid Fishes in the Columbia River Ecosystem. Northwest Power Planning Council. Portland, Oregon. 500 p.

Irving, J. S., and T. C. Bjornn. 1981. Status of Snake River fall chinook salmon in relation to the Endangered Species Act. Idaho Cooperative Fishery Research Unit, University of Idaho, Moscow, for U.S. Fish and Wildlife Service.

Jessup, E.L., and K. L. Casavant. Impact of Snake River Drawdown on transportation of grains in Eastern Washington: competitive and rail car constraints. 1998. Eastern Washington Intermodal Transportation Study Research Report 24. http://ewits.wsu.edu/reports.htm

Lee, D. C., J. R. Sedell, B. E. Rieman, R. F. Thurow, and J. E. Williams. 1997. Broadscale Assessment of Aquatic Species and Habitats. Volume III, Chapter 4. U.S. For. Serv., Gen. Tech. Rep. PNW-GTR-405. Portland, Oregon.

Lohn, B. 2002. Letter to Frank L. Cassidy announcing the development of interim abundance and productivity targets for Interior Columbia Basin salmon and steelhead listed under the Endangered Species Act. NOAA Fisheries, Seattle, Washington.

Mackay, R.J. 1992. Colonization by lotic macroinvertebrates: a review of processes and patterns. Can. J. Aquat. Sci. 49: 617-628.

Maser, Chris & James R. Sedell. 1994. From the Forest to the Sea: The Ecology of Wood in Streams, Rivers, Estuaries, and Oceans. St. Lucie Press, Delray Beach, Florida.

Matthews, G. M., and R.S. Waples. 1991. Status Review for Snake River spring and summer chinook salmon. National Marine Fisheries Service, Northwest Fisheries Science Center, Coastal Zone and Estuarine Studies Division, NOAA Technical Memorandum, Seattle Washington

McClure, M.M., B.Sanderson, E. Holmes, C. Jordan, P. Kareiva, and P. Levin. 2000. Revised Appendix B of standardized quantitative analysis of the risks faced by salmonids in the Columbia River basin. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. September.

McClure, M.M., E Holmes, B. Sanderson, and C. Jordan. 2003. A Large-Scale Multispecies Status Assessment: Anadromous Salmonids in the Columbia River Basin. Ecological Applications 13 (4): 964-989.

McElhany, P., M. Ruckleshaus, M. J. Ford, T. Wainwright, and E. Bjorkstedt. 2000. Viable Salmon Populations and the Recovery of Evolutionarily Significant Units. U. S. Dept. Commer., NOAA Technical Memorandum NMFS-NWFSC-42.

McIntosh, B.A., J.R. Sedell, J.E. Smith, R.C. Wissmar, S.E. Clarke, G.H. Reeves, and L.A. Brown. 1994. Management History of Eastside Ecosystems: Changes in Fish Habitat Over 50 Years, 1935 to 1992. USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-321. February.

Meyers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. Commerce., NOAA Tech. Memo. NMFS-NWFSC-35, 443 p.

Moore, A., and C. P. Waring. 1996. Sublethal effects of the pesticide Diazanon on olfactory function in mature male Atlantic salmon parr. J. Fish. Biol. 48: 758-775.

Mueller, R.P. 2003. Survey of Approaches to Navigation Locks Downstream from Lower Granite and Lower Monumental Dams for Fall Chinook Salmon Redds, December 2002. Prepared for the U.S. Army Corps of Engineers, Walla Walla District by Battelle, Pacific Northwest Laboratory, Richland, Washington.

Naiman, R. J., T. J. Beechie, L. E. Benda, D. R. Berg, P. A. Bisson, L. H. MacDonald, M. D. O'Connor, P. L. Olson, and E. A. Steel. 1992. Fundamental Elements of Ecologically Healthy Watersheds in the Pacific Northwest Coastal Ecoregion. P. 127-188. In: R.S. Naiman, ed. Watershed Management — Balancing Sustainability and Environmental Change. Springer-Verlag, N.Y.

National Research Council. 1996. Upstream—Salmon and Society in the Pacific Northwest. National Academy Press, Washington, D.C.

Nehlsen, W. 1997. Prioritizing Watersheds in Oregon for Salmon Restoration. Restoration Ecology 5(4S):25-43.

NMFS (National Marine Fisheries Service) 1996. Making Endangered Species Act Determinations of Effect for Individual and Grouped Actions at the Watershed Scale. Habitat Conservation Program, Portland, Oregon.

NMFS (National Marine Fisheries Service) 1999a. The Habitat Approach. Implementation of Section 7 of the Endangered Species Act for Actions Affecting the Habitat of Pacific Anadromous Salmonids. Northwest Region, Habitat Conservation and Protected Resources

Divisions, August 26.

NMFS (National Marine Fisheries Service). 1999b. Biological opinion on artificial propagation in the Columbia River basin – incidental take of listed salmon and steelhead from Federal and non-Federal hatchery programs that collect, rear, and release unlisted fish species. NMFS, Endangered Species Act Section 7 consultation. March 29.

NMFS (National Marine Fisheries Service) 2000. Biological Opinion -- Reinitiation of Consultation on Operation of the Federal Columbia River Power System, Including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin. Hydro Program, Portland, Oregon. (Issued December 21, 2000).

NWPPC (Northwest Power Planning Council). 1989. Snake River subbasin salmon and steelhead NWPPC, Portland, Oregon.

Newcombe, C.P., and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. 16: 693 -727.

Oregon Progress Board. 2000. Oregon State of the Environment Report 2000. Oregon Progress Board, Salem, Oregon.

PFMC 1999. Amendment 14 to the Pacific Coast Salmon Plan. Appendix A: Description and Identification of Essential Fish Habitat, Adverse Impacts and Recommended Conservation Measures for Salmon. Pacific Fishery Management Council, Portland, Oregon.

Reckendorf, Frank, and Paul Pedone. 1989. Erosion and Sediment Impacts of the 1985 Food Security Act Above the Lower Granite Reservoir, Idaho, Oregon, and Washington. Proceedings of National Nonpoint Source Conference, 1989.

Rhodes, J.J., D.A. McCullough, and F.A. Espinosa, Jr. 1994. A Coarse Screening Process for Potential Application in ESA Consultations. Columbia River Intertribal Fish Commission. Prepared under NMFS/BIA Inter-Agency Agreement 40ABNF3. December.

Scholz, N. L., N. K. Truelove, B. L. French, B. A. Berejekian, T.P. Quin, E. Casillas, and T. K. Collier. Diazanon disrupts antipredator and homing behaviors in chinook salmon (Oncorhynchus tshawytscha). Can. J. Fish Aquat. Sci. 57:1911-1918.

Sedell, J.R. and J.L. Froggatt. 1984. Importance of Streamside Forests to Large Rivers: The Isolation of theWillamette River, Oregon, USA, from Its Floodplain by Snagging and Streamside Forest Removal. Internationale Vereinigung fur theoretische und angewandte Limnologie Verhandlungen 22:1828-1834.

Servizi, J. A., and D. W. Martens. 1987. Some effects of suspended Fraser River sediments on sockeye salmon (Oncorhynchus nerka), p. 254-264. In H. D. Smith, L. Margolis, and C. C.

Wood [ed.] Sockeye salmon (Oncorhynchus nerka) population biology and future management. Can. Spec. Publ. Fish. Aquat. Sci. 96.

Servizi, J. A., and D. W. Martens. 1992. Sublethal responses of coho salmon (Oncorhynchus kisutch) to suspended sediments. Can. J. Fish. Aquat. Sci. 49: 1389-1395.

Sigler, J. W., T.C. Bjornn, and F. H. Everest. 1984. Effects of chronic turbidity on density and growth of steelhead and coho salmon. Trans. Am. Fish. Soc. 113: 142-150.

Simmons, D. 2000. Excel spreadsheet: Snake River fall chinook, annual adult equivalent exploitation rates (AEQ Catch/[AEQ Catch + Escapement]) adjusted to joint staff estimates of ocean escapement. E-mail. National Marine Fisheries Service, Sustainable Fisheries Division, Seattle, Washington. October 2.

Spence, B. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, Oregon.

Waples, R. S., O. W. Johnson, and R. P. Jones, Jr. 1991. Status review for Snake River sockeye salmon. National Marine Fisheries Service, Northwest Fisheries Science Center, NOAA Technical Memorandum NMFS F/NWC-195, Seattle, Washington.

Waples, R. S. 1999. Dispelling some myths about hatcheries. Fisheries 24(2):12-21.

Waring, C. P., and A. Moore. 1997. Sublethal effects of a carbamate pesticide on pheromonal mediated endocrine function in mature male Atlantic salmon (Salmo salar L.) parr. Fish Physiology and Biochemistry 17: 203-211.

Waters, T.F. 1995. Sediment in streams: sources, biological effects, and control. American Fisheries Society Monograph 7. 251 pp.

Wissmar, R.C., J.E. Smith, B.A. McIntosh, H.W. Li, G.H. Reeves, and J.R. Sedell. 1994. Ecological Health of River Basins in Forested Regions of Eastern Washington and Oregon. Gen. Tech. Rep. PNW-GTR-326. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR. 65 p.